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*January 11, 2005*

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**APPLICATION NUMBER:** ***60/531,300***
**FILING DATE:** ***December 19, 2003***
**RELATED PCT APPLICATION NUMBER:** ***PCT/US04/42302***

UNITED STATES PATENT AND TRADEMARK OFFICE
DEPARTMENT OF COMMERCE

Certified By

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17264 U.S.PTO
121903

PTO/SB/16 (08-03)
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**PROVISIONAL APPLICATION FOR PATENT COVER SHEET**

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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22264 U.S. PTO
60/531300
121903

**INVENTOR(S)**

| Given Name (first and middle [if any]) | Family Name or Surname | Residence (City and either State or Foreign Country) |
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| BRUCE LAWRENCE | FINKELSTEIN | NEWARK, DELAWARE |

*Additional inventors are being named on the* ______ *separately numbered sheets attached hereto*

**TITLE OF THE INVENTION (500 characters max)**

HERBICIDAL PYRIMIDINES

*Direct all correspondence to:* **CORRESPONDENCE ADDRESS**

☑ Customer Number: **23906**

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**ENCLOSED APPLICATION PARTS** ***(check all that apply)***

☑ Specification *Number of Pages* 61

☐ Drawing(s) *Number of Sheets* ______

☐ Application Date Sheet. See 37 CFR 1.76

☐ CD(s), Number ______

☐ Other (specify) ______

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees.

☑ The Director is herby authorized to charge filing fees or credit any overpayment to Deposit Account Number: **04-1928**

☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE Amount ($): $160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______



*Respectfully submitted,*

SIGNATURE Linda D. Birch

TYPED or PRINTED NAME LINDA D. BIRCH

TELEPHONE (302) 992-4949

Date DECEMBER 19, 2003

REGISTRATION NO. 38,719
*(if appropriate)*
Docket Number: BA9323USPRV

***USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT***

121903 U.S. PTO 17264

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# FEE TRANSMITTAL for FY 2004

*Effective 10/01/2003. Patent fees are subject to annual revision.*

☐ Applicant claims small entity status. See 37 CFR 1.27

**TOTAL AMOUNT OF PAYMENT** ($) 160.00

| Complete if Known | |
|---|---|
| Application Number | UNKNOWN |
| Filing Date | HEREWITH |
| First Named Inventor | DAVID A. CLARK |
| Examiner Name | UNKNOWN |
| Art Unit | UNKNOWN |
| Attorney Docket No. | BA9323 US PRV |

## METHOD OF PAYMENT (*check all that apply*)

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☑ Deposit Account:

Deposit Account Number: **04-1928**

Deposit Account Name: **E. I. du Pont de Nemours and Company**

**The Director is authorized to:** (*check all that apply*)

☑ Charge fee(s) indicated below ☑ Credit any overpayments

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## FEE CALCULATION

### 1. BASIC FILING FEE

| Large Entity Fee Code | Large Entity Fee ($) | Small Entity Fee Code | Small Entity Fee ($) | Fee Description | Fee Paid |
|---|---|---|---|---|---|
| 1001 | 770 | 2001 | 385 | Utility filing fee | |
| 1002 | 340 | 2002 | 170 | Design filing fee | |
| 1003 | 530 | 2003 | 265 | Plant filing fee | |
| 1004 | 770 | 2004 | 385 | Reissue filing fee | |
| 1005 | 160 | 2005 | 80 | Provisional filing fee | 160.00 |

**SUBTOTAL (1)** ($) 160.00

### 2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

| | | | Extra Claims | | Fee from below | | Fee Paid |
|---|---|---|---|---|---|---|---|
| Total Claims | | -20** = | | X | 18 | = | |
| Independent Claims | | - 3** = | | X | 86 | = | |
| Multiple Dependent | ☐ YES | | | | 290.00 | = | |

| Large Entity Fee Code | Large Entity Fee ($) | Small Entity Fee Code | Small Entity Fee ($) | Fee Description |
|---|---|---|---|---|
| 1202 | 18 | 2202 | 9 | Claims in excess of 20 |
| 1201 | 86 | 2201 | 43 | Independent claims in excess of 3 |
| 1203 | 290 | 2203 | 145 | Multiple dependent claim, if not paid |
| 1204 | 86 | 2204 | 43 | ** Reissue independent claims over original patent |
| 1205 | 18 | 2205 | 9 | ** Reissue claims in excess of 20 and over original patent |

**SUBTOTAL (2)** ($) 0.00

**or number previously paid, if greater; For Reissues, see above

## FEE CALCULATION (continued)

### 3. ADDITIONAL FEES

| Large Entity Fee Code | Large Entity Fee ($) | Small Entity Fee Code | Small Entity Fee ($) | Fee Description | Fee Paid |
|---|---|---|---|---|---|
| 1051 | 130 | 2051 | 65 | Surcharge - late filing fee or oath | |
| 1052 | 50 | 2052 | 25 | Surcharge - late provisional filing fee or cover sheet | |
| 1053 | 130 | 1053 | 130 | Non-English specification | |
| 1812 | 2,520 | 1812 | 2,520 | For filing a request for *ex parte* reexamination | |
| 1804 | 920* | 1804 | 920* | Requesting publication of SIR prior to Examiner action | |
| 1805 | 1,840* | 1805 | 1,840* | Requesting publication of SIR after Examiner action | |
| 1251 | 110 | 2251 | 55 | Extension for reply within first month | |
| 1252 | 420 | 2252 | 210 | Extension for reply within second month | |
| 1253 | 950 | 2253 | 475 | Extension for reply within third month | |
| 1254 | 1,480 | 2254 | 740 | Extension for reply within fourth month | |
| 1255 | 2,010 | 2255 | 1,005 | Extension for reply within fifth month | |
| 1401 | 330 | 2401 | 165 | Notice of Appeal | |
| 1402 | 330 | 2402 | 165 | Filing a brief in support of an appeal | |
| 1403 | 290 | 2403 | 145 | Request for oral hearing | |
| 1451 | 1,510 | 1451 | 1,510 | Petition to institute a public use proceeding | |
| 1452 | 110 | 2452 | 55 | Petition to revive - unavoidable | |
| 1453 | 1,330 | 2453 | 665 | Petition to revive - unintentional | |
| 1501 | 1,330 | 2501 | 665 | Utility issue fee (or reissue) | |
| 1502 | 480 | 2502 | 240 | Design issue fee | |
| 1503 | 640 | 2503 | 320 | Plant issue fee | |
| 1460 | 130 | 1460 | 130 | Petitions to the Commissioner | |
| 1807 | 50 | 1807 | 50 | Processing fee under 37 CFR 1.17(q) | |
| 1806 | 180 | 1806 | 180 | Submission of Information Disclosure Stmt | |
| 8021 | 40 | 8021 | 40 | Recording each patent assignment per property (times number of properties) | |
| 1809 | 770 | 2809 | 385 | Filing a submission after final rejection (37 CFR 1.129(a)) | |
| 1810 | 770 | 2810 | 385 | For each additional invention to be examined (37 CFR 1.129(b)) | |
| 1801 | 770 | 2801 | 385 | Request for Continued Examination (RCE) | |
| 1802 | 900 | 1802 | 900 | Request for expedited examination of a design application | |

Other fee (specify) ____________

*Reduced by Basic Filing Fee Paid

**SUBTOTAL (3)** ($) 0.00

| SUBMITTED BY | | | | (Complete (*if applicable*)) | |
|---|---|---|---|---|---|
| Name (*Print/Type*) | Linda D. Birch | Registration No. (*Attorney/Agent*) | 38,719 | Telephone | (302) 992-4949 |
| Signature | Linda D. Birch | | | Date | DECEMBER 19, 2003 |

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# TITLE
# HERBICIDAL PYRIMIDINES

## FIELD OF THE INVENTION

This invention relates to certain pyrimidines, their *N*-oxides, agriculturally suitable salts and compositions, and methods of their use for controlling undesirable vegetation.

## BACKGROUND OF THE INVENTION

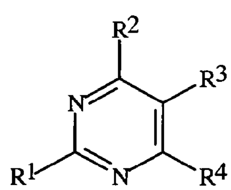
The control of undesired vegetation is extremely important in achieving high crop efficiency. Achievement of selective control of the growth of weeds especially in such useful crops as rice, soybean, sugar beet, corn (maize), potato, wheat, barley, tomato and plantation crops, among others, is very desirable. Unchecked weed growth in such useful crops can cause significant reduction in productivity and thereby result in increased costs to the consumer. The control of undesired vegetation in noncrop areas is also important. Many products are commercially available for these purposes, but the need continues for new compounds which are more effective, less costly, less toxic, environmentally safer or have different modes of action.

European Patent Publication EP-519211-A1 discloses pyrimidines useful for controlling insects, mites and certain other animal invertebrates. This reference does not disclose the compounds of the present invention or their herbicidal utility.

## SUMMARY OF THE INVENTION

This invention is directed to a compound of Formula **I**, including all geometric and stereoisomers, *N*-oxides or agriculturally suitable salts thereof, agricultural compositions containing them and their use as herbicides:

This invention is directed to a compound of Formula **I** including all geometric and stereoisomers, *N*-oxides or agriculturally suitable salts thereof, agricultural compositions containing them and their use as herbicides:



**I**

wherein

$R^1$ is cyclopropyl optionally substituted with 1–5 $R^5$, isopropyl optionally substituted with 1–5 $R^6$, or phenyl optionally substituted with 1–2 $R^7$; or $R^1$ is halogen, $OR^8$, $SR^9$ or $N(R^{10})R^{11}$;

$R^2$ is $CO_2R^{12}$, $CH_2OR^{13}$, CHO, $C(=NOR^{14})H$, $C(R^{15})(R^{16})CO_2R^{17}$ or $C(=O)N(R^{18})R^{19}$;

$R^3$ is halogen, cyano, nitro, $OR^{20}$, $SR^{21}$ or $N(R^{22})R^{23}$;

$R^4$ is $-N(R^{24})R^{25}$ or $-NO_2$;

each $R^5$ and $R^6$ is independently halogen, $C_1$–$C_2$ alkyl or $C_1$–$C_2$ haloalkyl;

each $R^7$ is independently halogen, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl, $C_1$–$C_3$ alkoxy, $C_1$–$C_3$ haloalkoxy, $C_1$–$C_3$ alkylthio or $C_1$–$C_3$ haloalkylthio;

$R^8$ is H, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl or phenyl optionally substituted with 1–2 $R^{26}$;

$R^9$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{10}$ is H or $C_1$–$C_4$ alkyl;

$R^{11}$ is $C_1$–$C_4$ alkyl;

or $R^{10}$ and $R^{11}$ are taken together as $-(CH_2)_m-$ or $-(CH_2)_2O(CH_2)_2-$;

$R^{12}$ is H; or a radical selected from $C_1$–$C_{14}$ alkyl, $C_3$–$C_{12}$ cycloalkyl, $C_4$–$C_{12}$ alkylcycloalkyl, $C_4$–$C_{12}$ cycloalkylalkyl, $C_2$–$C_{14}$ alkenyl and $C_2$–$C_{14}$ alkynyl, each radical optionally substituted with 1–3 $R^{27}$;

$R^{13}$ is H, $C_1$–$C_{10}$ alkyl optionally substituted with 1–3 $R^{28}$ or benzyl;

$R^{14}$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_4$ haloalkyl;

$R^{15}$ and $R^{16}$ are independently H, halogen, $C_1$–$C_4$ alkyl, $C_1$–$C_4$ haloalkyl, hydroxy or $C_1$–$C_4$ alkoxy;

$R^{17}$ is $C_1$–$C_{10}$ alkyl optionally substituted with 1–3 $R^{29}$ or benzyl;

$R^{18}$ and $R^{19}$ are independently H or $C_1$–$C_4$ alkyl;

$R^{20}$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{21}$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{22}$ and $R^{23}$ are independently H or $C_1$–$C_4$ alkyl;

$R^{24}$ is H, $C_1$–$C_4$ alkyl optionally substituted with 1–2 $R^{30}$, $C_2$–$C_4$ alkenyl optionally substituted with 1–2 $R^{31}$, or $C_2$–$C_4$ alkynyl optionally substituted with 1–2 $R^{32}$; or $R^{24}$ is $C(=O)R^{33}$, nitro, $OR^{34}$, $S(O)_2R^{35}$ or $N(R^{36})R^{37}$;

$R^{25}$ is H, $C_1$–$C_4$ alkyl optionally substituted with 1–2 $R^{30}$ or $C(=O)R^{33}$; or

$R^{24}$ and $R^{25}$ are taken together as a radical selected from $-(CH_2)_4-$, $-(CH_2)_5-$, $-CH_2CH=CHCH_2-$ and $-(CH_2)_2O(CH_2)_2-$, each radical optionally substituted with 1–2 $R^{38}$; or

$R^{24}$ and $R^{25}$ are taken together as $=C(R^{39})N(R^{40})R^{41}$ or $=C(R^{42})OR^{43}$;

each $R^{26}$ is independently halogen, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl, $C_1$–$C_3$ alkoxy, $C_1$–$C_3$ haloalkoxy, $C_1$–$C_3$ alkylthio or $C_1$–$C_3$ haloalkylthio;

each $R^{27}$ is independently halogen, hydroxycarbonyl, $C_2$–$C_4$ alkoxycarbonyl, hydroxy, $C_1$–$C_4$ alkoxy, $C_1$–$C_4$ haloalkoxy, $C_1$–$C_4$ alkylthio, $C_1$–$C_4$ haloalkylthio, amino, $C_1$–$C_4$ alkylamino, $C_1$–$C_4$ dialkylamino, $-CH\{O(CH_2)_n\}$ or phenyl optionally substituted with 1–3 $R^{44}$; or

two $R^{27}$ are taken together with the carbon atom to which they are attached to form a carbonyl moiety;

each $R^{28}$ and $R^{29}$ is independently halogen, $C_1$–$C_4$ alkoxy, $C_1$–$C_4$ haloalkoxy, $C_1$–$C_4$ alkylthio, $C_1$–$C_4$ haloalkylthio, amino, $C_1$–$C_4$ alkylamino or $C_1$–$C_4$ dialkylamino;

each $R^{30}$, $R^{31}$ and $R^{32}$ is independently halogen, hydroxy, $C_1$–$C_4$ alkoxy, $C_1$–$C_4$ haloalkoxy, $C_1$–$C_4$ alkylthio, $C_1$–$C_4$ haloalkylthio, amino, $C_1$–$C_4$ alkylamino, $C_1$–$C_4$ dialkylamino or $C_2$–$C_4$ alkoxycarbonyl;

each $R^{33}$ is independently H, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl, $C_1$–$C_4$ alkoxy, phenoxy or benzyloxy;

$R^{34}$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{35}$ is $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{36}$ and $R^{37}$ are independently H or $C_1$–$C_4$ alkyl;

each $R^{38}$ is independently halogen, $C_1$–$C_3$ alkyl, $C_1$–$C_3$ alkoxy, $C_1$–$C_3$ haloalkoxy, $C_1$–$C_3$ alkylthio, $C_1$–$C_3$ haloalkylthio, amino, $C_1$–$C_3$ alkylamino, $C_1$–$C_4$ dialkylamino or $C_2$–$C_4$ alkoxycarbonyl;

$R^{39}$ is H or $C_1$–$C_4$ alkyl;

$R^{40}$ and $R^{41}$ are independently H or $C_1$–$C_4$ alkyl; or

$R^{40}$ and $R^{41}$ are taken together as $-(CH_2)_4-$, $-(CH_2)_5-$, $-CH_2CH{=}CHCH_2-$ or $-(CH_2)_2O(CH_2)_2-$;

$R^{42}$ is H or $C_1$–$C_4$ alkyl;

$R^{43}$ is H or $C_1$–$C_4$ alkyl;

each $R^{44}$ is independently halogen, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl, hydroxy, $C_1$–$C_4$ alkoxy, $C_1$–$C_3$ haloalkoxy, $C_1$–$C_4$ alkylthio, $C_1$–$C_3$ haloalkylthio, amino, $C_1$–$C_3$ alkylamino, $C_1$–$C_4$ dialkylamino or nitro;

m is an integer from 2 to 5; and

n is an integer from 1 to 4;

provided that:

(a) when $R^2$ is $CH_2OR^{13}$, then $R^1$ is other than $SCH_3$, and $R^{24}$ and $R^{25}$ are H;

(b) when $R^1$ and $R^3$ are halogen, then $R^4$ is $NH_2$; and

(c) when $R^1$ is $SCH_3$, then $R^3$ is Cl.

More particularly, this invention pertains to a compound of Formula **I**, including all geometric and stereoisomers, *N*-oxides or agriculturally suitable salts thereof. This invention also relates to a herbicidal composition comprising a herbicidally effective amount of a compound of Formula **I** and at least one of a surfactant, a solid diluent or a liquid diluent. This invention further relates to a method for controlling the growth of undesired vegetation comprising contacting the vegetation or its environment with a herbicidally effective amount of a compound of Formula **I** (e.g., as a composition described herein). This invention also

relates to a herbicidal composition comprising a herbicidally effective amount of a compound of Formula **I**, an effective amount of at least one additional active ingredient selected from the group consisting of an other herbicide and a herbicide safener, and at least one of a surfactant, a solid diluent or a liquid diluent.

## DETAILS OF THE INVENTION

In the above recitations, the term "alkyl", used either alone or in compound words such as "alkylthio" or "haloalkyl" includes straight-chain or branched alkyl, such as, methyl, ethyl, *n*-propyl, *i*-propyl, or the different butyl, pentyl or hexyl isomers. "Alkenyl" includes straight-chain or branched alkenes such as ethenyl, 1-propenyl, 2-propenyl, and the different butenyl, pentenyl and hexenyl isomers. "Alkenyl" also includes polyenes such as 1,2-propadienyl and 2,4-hexadienyl. "Alkoxy" includes, for example, methoxy, ethoxy, *n*-propyloxy, isopropyloxy and the different butoxy, pentoxy and hexyloxy isomers. "Alkoxyalkyl" denotes alkoxy substitution on alkyl. "Alkylthio" includes branched or straight-chain alkylthio moieties such as methylthio, ethylthio, and the different propylthio, butylthio, pentylthio and hexylthio isomers. "Alkylamino", "dialkylamino", and the like, are defined analogously to the above examples. "Cycloalkyl" includes, for example, cyclopropyl, cyclobutyl, cyclopentyl, and cyclohexyl. Examples of "cycloalkylalkyl" include cyclopropylmethyl, cyclopentylethyl, and other cycloalkyl moieties bonded to straight-chain or branched alkyl groups. "Alkylcycloalkyl" denotes alkyl substitution on a cycloalkyl moiety. Examples include 4-methylcyclohexyl and 3-ethylcyclopentyl. One skilled in the art will recognize that pyrimidine heterocycles and tertiary amines can form *N*-oxides. Synthetic methods for the preparation of *N*-oxides of heterocycles and tertiary amines are very well known by one skilled in the art including the oxidation of heterocycles and tertiary amines with peroxy acids such as peracetic and *m*-chloroperbenzoic acid (MCPBA), hydrogen peroxide, alkyl hydroperoxides such as *t*-butyl hydroperoxide, sodium perborate, and dioxiranes such as dimethydioxirane. These methods for the preparation of *N*-oxides have been extensively described and reviewed in the literature, see for example: T. L. Gilchrist in *Comprehensive Organic Synthesis*, vol. 7, pp 748–750, S. V. Ley, Ed., Pergamon Press; M. Tisler and B. Stanovnik in *Comprehensive Heterocyclic Chemistry*, vol. 3, pp 18–20, A. J. Boulton and A. McKillop, Eds., Pergamon Press; M. R. Grimmett and B. R. T. Keene in *Advances in Heterocyclic Chemistry*, vol. 43, pp 149–161, A. R. Katritzky, Ed., Academic Press; M. Tisler and B. Stanovnik in *Advances in Heterocyclic Chemistry*, vol. 9, pp 285–291, A. R. Katritzky and A. J. Boulton, Eds., Academic Press; and G. W. H. Cheeseman and E. S. G. Werstiuk in *Advances in Heterocyclic Chemistry*, vol. 22, pp 390–392, A. R. Katritzky and A. J. Boulton, Eds., Academic Press.

The term "halogen", either alone or in compound words such as "haloalkyl", includes fluorine, chlorine, bromine or iodine. The term "1–2 halogen" indicates that one or two of the available positions for that substituent may be halogen which are independently selected.

Further, when used in compound words such as "haloalkyl", said alkyl may be partially or fully substituted with halogen atoms which may be the same or different. Examples of "haloalkyl" include $F_3C$, $ClCH_2$, $CF_3CH_2$ and $CF_3CCl_2$. Examples of "haloalkoxy" include $CF_3O$, $CCl_3CH_2O$, $HCF_2CH_2CH_2O$ and $CF_3CH_2O$. Examples of "haloalkylthio" include $CCl_3S$, $CF_3S$, $CCl_3CH_2S$ and $ClCH_2CH_2CH_2S$.

The total number of carbon atoms in a substituent group is indicated by the "$C_i$–$C_j$" prefix where i and j are numbers from 1 to 14. For example, $C_1$–$C_3$ alkylthio designates methylthio through propylthio. Examples of $C_2$–$C_4$ alkoxycarbonyl include $CH_3OC(=O)$, $CH_3CH_2OC(=O)$, $CH_3CH_2CH_2OC(=O)$ and $(CH_3)_2CHOC(=O)$.

Compounds of this invention can exist as one or more stereoisomers. The various stereoisomers include enantiomers, diastereomers, atropisomers and geometric isomers. One skilled in the art will appreciate that one stereoisomer may be more active and/or may exhibit beneficial effects when enriched relative to the other stereoisomer(s) or when separated from the other stereoisomer(s). Additionally, the skilled artisan knows how to separate, enrich, and/or to selectively prepare said stereoisomers. Accordingly, the present invention comprises compounds selected from Formula I, *N*-oxides and agriculturally suitable salts thereof. The compounds of the invention may be present as a mixture of stereoisomers, individual stereoisomers, or as an optically active form.

The agriculturally suitable salts of the compounds of the invention include acid-addition salts with inorganic or organic acids such as hydrobromic, hydrochloric, nitric, phosphoric, sulfuric, acetic, butyric, fumaric, lactic, maleic, malonic, oxalic, propionic, salicylic, tartaric, 4-toluenesulfonic or valeric acids. The agriculturally suitable salts of the compounds of the invention also include those formed with strong bases (e.g., hydrides or hydroxides of sodium, potassium or lithium). One skilled in the art recognizes that because in the environment and under physiological conditions salts of the compounds of the invention are in equilibrium with their corresponding nonsalt forms, agriculturally suitable salts share the biological utility of the nonsalt forms.

Preferred for reason of cost, ease of synthesis and/or biological efficacy is:

Preferred 1. A compound of Formula **I** wherein $R^1$ is cyclopropyl.

Preferred 2. A compound of Formula **I** wherein $R^2$ is $CO_2R^{12}$, $CH_2OR^{13}$, CHO or $CH_2CO_2R^{17}$.

Preferred 3. A compound of Preferred 2 wherein $R^2$ is $CO_2R^{12}$.

Preferred 4. A compound of Preferred 3 wherein $R^{12}$ is H or $C_1$–$C_4$ alkyl.

Preferred 5. A compound of Preferred 4 wherein $R^{12}$ is $C_1$–$C_2$ alkyl.

Preferred 6. A compound of Formula **I** wherein $R^3$ is halogen.

Preferred 7. A compound of Preferred 6 wherein $R^3$ is Br or Cl.

Preferred 8. A compound of Preferred 7 wherein $R^3$ is Cl.

Preferred 9. A compound of Formula **I** wherein $R^4$ is $-N(R^{24})R^{25}$.

Preferred 10. A compound of Preferred 9 wherein $R^{24}$ is H or $C_1$–$C_4$ alkyl optionally substituted with $R^{30}$; $R^{25}$ is H or $C_1$–$C_2$ alkyl; or $R^{24}$ and $R^{25}$ are taken together as $=C(R^{39})N(R^{40})R^{41}$.

Preferred 11. A compound of Preferred 10 wherein $R^{24}$ is H or $C_1$–$C_4$ alkyl optionally substituted with $R^{30}$; and $R^{25}$ is H or $C_1$–$C_2$ alkyl.

Preferred 12. A compound of Preferred 11 wherein $R^{24}$ and $R^{25}$ are independently H or methyl.

Preferred 13. A compound of Preferred 12 wherein $R^{24}$ and $R^{25}$ are H.

Preferred 14. A compound of Formula **I** wherein $R^{30}$ is halogen, methoxy, $C_1$ fluoroalkoxy, methylthio, $C_1$ fluoroalkylthio, amino, methylamino, dimethylamino or methoxycarbonyl.

Preferred 15. A compound of Formula **I** wherein $R^{39}$ is H or $C_1$–$C_2$ alkyl.

Preferred 16. A compound of Formula **I** wherein $R^{40}$ and $R^{41}$ are independently H or $C_1$–$C_2$ alkyl.

Combinations of preferred groups are illustrated by:

Preferred A. A compound of Formula **I** wherein $R^1$ is cyclopropyl; and $R^4$ is $-N(R^{24})R^{25}$.

Preferred B. A compound of Preferred A wherein $R^2$ is $CO_2R^{12}$; and $R^{24}$ and $R^{25}$ are H.

Preferred C. A compound of Preferred A wherein $R^3$ is halogen.

Preferred D. A compound of Preferred C wherein $R^2$ is $CO_2R^{12}$, $CH_2OR^{13}$, CHO or $CH_2CO_2R^{17}$.

Preferred E. A compound of Preferred D wherein $R^{24}$ is H or $C_1$–$C_4$ alkyl optionally substituted with $R^{30}$; $R^{25}$ is H or $C_1$–$C_2$ alkyl; or $R^{24}$ and $R^{25}$ are taken together as $=C(R^{39})N(R^{40})R^{41}$.

Preferred F. A compound of Preferred E wherein $R^2$ is $CO_2R^{12}$; and $R^{12}$ is H or $C_1$–$C_4$ alkyl.

Preferred G. A compound of Preferred F wherein $R^{24}$ and $R^{25}$ are H.

Specifically preferred is a compound of Formula **I** selected from the group consisting of:

methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate,

ethyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate,

methyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate, and

ethyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate.

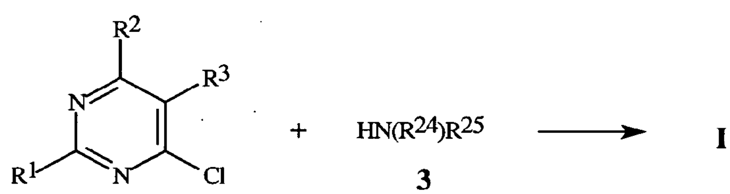
The preferred herbicidal compositions of the present invention are those involving the above preferred compounds.

This invention also relates to a method for controlling undesired vegetation comprising applying to the locus of the vegetation herbicidally effective amounts of the compounds of the invention (e.g., as a composition described herein). The preferred methods of use are those involving the above preferred compounds.

The compounds of Formula **I** can be prepared by one or more of the following methods and variations as described in Schemes 1 through 7 and accompanying text. The definitions of $R^1$, $R^2$, $R^3$, $R^4$, $R^5$, $R^6$, $R^7$, $R^8$, $R^9$, $R^{10}$, $R^{11}$, $R^{12}$, $R^{13}$, $R^{14}$, $R^{15}$, $R^{16}$, $R^{17}$, $R^{18}$, $R^{19}$, $R^{20}$, $R^{21}$, $R^{22}$, $R^{23}$, $R^{24}$, $R^{25}$, $R^{26}$, $R^{27}$, $R^{28}$, $R^{29}$, $R^{30}$, $R^{31}$, $R^{32}$, $R^{33}$, $R^{34}$, $R^{35}$, $R^{36}$, $R^{37}$, $R^{38}$, $R^{39}$, $R^{40}$, $R^{41}$, $R^{42}$, $R^{43}$, $R^{44}$, m and n in the compounds of Formulae **I** through **12** below are as defined above in the Summary of the Invention and description of preferred embodiments unless otherwise indicated.

Compounds of Formula **I** can be prepared from chlorides of Formula **2** by reaction with amines of Formula **3**, optionally in the presence of a base such as triethylamine or potassium carbonate as outlined in Scheme 1. The reaction can be run in a variety of solvents including tetrahydrofuran, *p*-dioxane, ethanol and methanol with optimum temperatures ranging from room temperature to 200 °C.

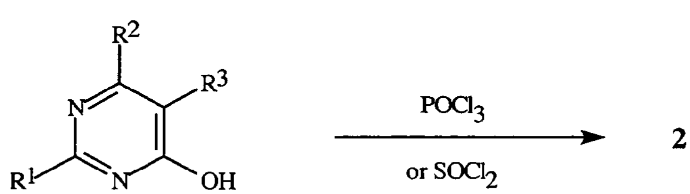
Scheme 1



**2**

Compounds of Formula **2** can be prepared from hydroxy compounds of Formula **4** (which may exist in the keto form) by reaction with a chlorination reagent such as phosphorous oxychloride or thionyl chloride, optionally in the presence of a base such as *N,N*-dimethylaniline as shown in Scheme 2. The reaction can be run neat or in the presence of a solvent such as *N,N*-dimethylformamide at temperatures ranging from room temperature to 120 °C.

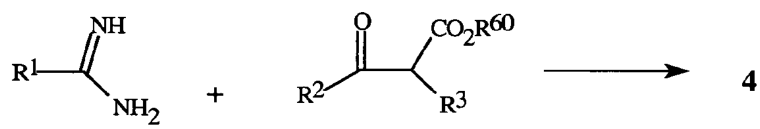
Scheme 2



**4**

Compounds of Formula **4** can be prepared by the condensation of amidines (or isoureas, isothioureas or guanidines) of Formula **5** with keto esters of Formula **6** in solvents such as methanol or ethanol at temperatures ranging from room temperature to the reflux temperature of the solvent as shown in Scheme 3. Optionally a base such as a metal alkoxide or 1,1,3,3-tetramethylguanidine may be employed.

Scheme 3




**5** **6**

wherein $R^{60}$ is a carbon moiety such as alkyl, preferably $C_1$–$C_2$ alkyl.

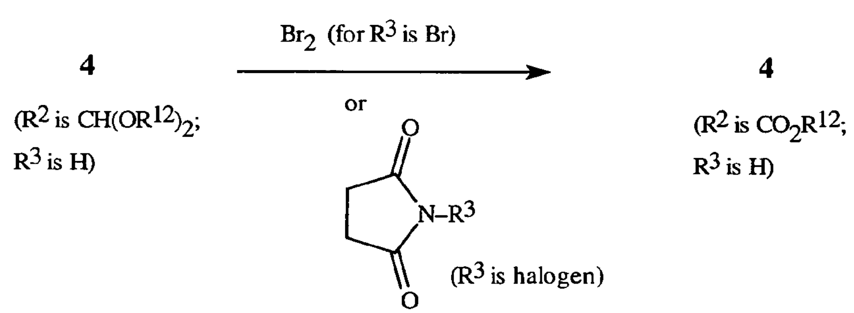
Compounds of Formula **4** wherein $R^3$ is a halogen can be prepared from compounds of Formula **4** where $R^3$ is hydrogen by reaction with a halogen such as bromine or a halogenating reagent such as an *N*-halosuccinimide in a variety of solvents including acetic acid, *N,N*-dimethylformamide, dichloromethane and carbon tetrachloride at temperatures ranging from 0–100 °C as shown in Scheme 4.

Scheme 4

$$\underset{(R^3 \text{ is H})}{\mathbf{4}} \xrightarrow{\text{halogenating reagent}} \underset{(R^3 \text{ is halogen})}{\mathbf{4}}$$

A particularly useful preparation of compounds of Formula **4** wherein $R^3$ is a halogen and $R^2$ is $CO_2R^{12}$ is the reaction of compounds of Formula **4** where $R^3$ is hydrogen and $R^2$ is $CH(OR^{12})_2$ with a halogenating reagent and oxidizing reagent such as an *N*-halosuccinimide or bromine (when $R^3$ is bromine) in a solvent such as dichloromethane, trichloromethane or tetrachloromethane at temperatures ranging from room temperature to the reflux temperature of the solvent as shown in Scheme 5.

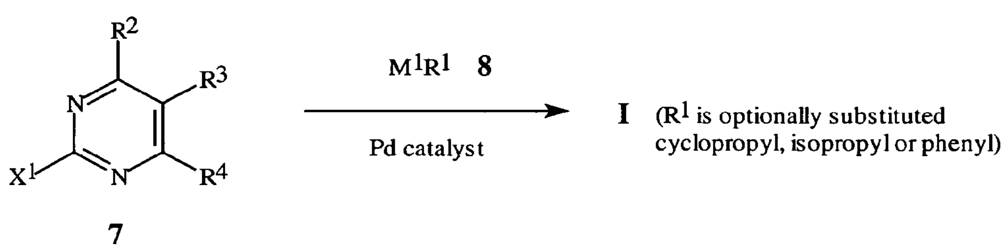
Scheme 5



Compounds of Formula **5** and **6** are either commercially available or can be prepared by known methods. (For example see: P. J. Dunn in *Comprehensive Organic Functional Group Transformations*, A. R. Katritzky, O. Meth-Cohn, C.W. Rees Eds, Pergamon Press; Oxford, 1995; vol. 5, pp.741–782; T.L. Gillchrist in *Comprehensive Organic Functional Group Transformations*, A. R. Katritzky, O. Meth-Cohn, C.W. Rees Eds., Pergamon Press; Oxford, 1995; vol. 6, pp. 601–637 and B. R. Davis, P. J. Garratt in *Comprehensive Organic Synthesis*, B. M. Trost Ed., Pergamom Press; Oxford, 1991; vol. 2, pp. 795–803.)

Alternatively compounds of Formula **I** wherein $R^1$ is an optionally substituted cyclopropyl, isopropyl or phenyl group can be prepared from corresponding compounds of Formula **7** wherein $X^1$ is a leaving group, such as a halogen or alkylsulfonyl group (e.g., methanesulfonyl, trifluoromethanesulfonyl, benzenesulfonyl), as shown in Scheme 6.

Scheme 6



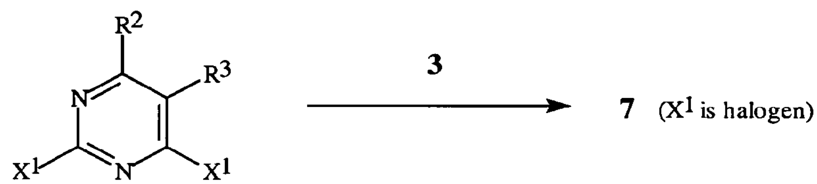

wherein $M^1$ is $B(OH)_2$, $Sn(n\text{-Bu})_3$, $MgX^1$ or $ZnX^1$; $R^1$ is optionally substituted cyclopropyl, optionally substituted isopropyl or optionally substituted phenyl; and $X^1$ is a leaving group.

This method involves palladium-catalyzed reaction of a compound of Formula **7** with a compound of Formula **8** in the form of a boronic acid (e.g., $M^1$ is $B(OH)_2$), an organotin reagent (e.g., $M^1$ is $Sn(n\text{-Bu})_3$), a Grignard reagent (e.g., $M^1$ is $MgX^1$) or an organozinc reagent (e.g., $M^1$ is $ZnX^1$). (For example see: N. Ali, A. McKillop, M. Mitchell, R. Rebelo, A. Ricardo, P. Wallbank, *Tetrahedron*, **1992**, *48*, 2273, J. Solberg, K. Jan, *Acta Chem. Scand.*, **1989**, *43*, 62, Undheim, V. Bonnet, F. Mongin, F. Trécourt, G. Quéguiner and P. Knochel, *Tetrahedron*, **2002**, *58*, 4429.)

Compounds of Formula **I** wherein $R^1$ is $OR^8$, $SR^9$ or $N(R^{10})R^{11}$ can be prepared by treating corresponding compounds of Formula **7** with $M^2OR^8$ (**9**), $M^2SR^9$ (**10**) or $HN(R^{10})R^{11}$ (**11**), respectively, wherein $M^2$ is typically an alkali metal in the form of a cation (e.g., Li, Na, K, Cs) or a quaternary ammonium (e.g., $(n\text{-Bu})_4N$). This type of reaction is well known the art. The reaction with the amine of Formula **11** can be conveniently conducted in the presence of excess amine if the amine is inexpensive and of low molecular weight. Otherwise good yields can be conveniently obtained from a equimolar amount or slight excess of the amine of Formula **11** in the presence of another base or acid-scavenger (e.g., triethylamine, $K_2CO_3$) not reactive with the compound of Formula **7**.

Compounds of Formula **7** wherein $X^1$ is a halogen can be prepared from dihalo compounds of Formula **12** with an amine of Formula **3** optionally catalyzed by a base such as triethylamine or potassium carbonate in a variety of solvents including tetrahydrofuran and dichloromethane at temperatures ranging from 0 °C to the reflux temperature of the solvent as shown in Scheme 7.

Scheme 7




**12** ($X^1$ is halogen)

Compounds of Formula **12** can be prepared by known methods. (For example, see Gershon, *J. Org. Chem.*, **1962**, *27*, 3507.)

It is recognized that some reagents and reaction conditions described above for preparing compounds of Formula **I** may not be compatible with certain functionalities present in the intermediates. In these instances, the incorporation of protection/deprotection sequences or functional group interconversions into the synthesis will aid in obtaining the desired products. The use and choice of the protecting groups will be apparent to one skilled in chemical synthesis (see, for example, T. W. Greene, P. G. M. Wuts, *Protective Groups in Organic Synthesis*, 2nd ed.; Wiley: New York, 1991). One skilled in the art will recognize that, in some cases, after the introduction of a given reagent as it is depicted in any individual scheme, it may be necessary to perform additional routine synthetic steps not described in detail to complete the synthesis of compounds of Formula **I**. One skilled in the art will also recognize that it may be necessary to perform a combination of the steps illustrated in the above schemes in an order other than that implied by the particular sequence presented to prepare the compounds of Formula **I**.

One skilled in the art will also recognize that compounds of Formula **I** and the intermediates described herein can be subjected to various electrophilic, nucleophilic, radical, organometallic, oxidation, and reduction reactions to add substituents or modify existing substituents.

Without further elaboration, it is believed that one skilled in the art using the preceding description can utilize the present invention to its fullest extent. The following Examples are, therefore, to be construed as merely illustrative, and not limiting of the disclosure in any way whatsoever. Steps in the following Examples illustrate a procedure for each step in an overall synthetic transformation, and the starting material for each step may not have necessarily been prepared by a particular preparative run whose procedure is described in

other Examples or Steps. Percentages are by weight except for chromatographic solvent mixtures or where otherwise indicated. Parts and percentages for chromatographic solvent mixtures are by volume unless otherwise indicated. $^1$H NMR spectra are reported in ppm downfield from tetramethylsilane; "s" means singlet, "d" means doublet, "t" means triplet, "q" means quartet, "m" means multiplet, "dd" means doublet of doublets, "ddd" means doublet of doublets of doublets, "dt" means doublet of triplets, "dq" means doublet of quartets, "br s" means broad singlet, "br d" means broad doublet.

EXAMPLE 1

Preparation of ethyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate (Compound 1) and methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate (Compound 2)

Step A: Preparation of 2-cyclopropyl-6-(diethoxymethyl)-4(1*H*)-pyrimidinone

To a mixture of ethyl 4,4-diethoxy-3-oxobutanoate (prepared according to the method of E. Graf, R. Troschutz, *Synthesis*, **1999**, *7*, 1216; 10.0 g, 46 mmol) and cyclopropanecarboximidamide monohydrochloride (Lancaster Synthesis, 5.0 g, 41 mmol) in methanol (100 mL) was added a methanol solution of sodium methoxide (5.4 M, 8.4 mL, 46 mmol). The reaction mixture was stirred overnight. The solvent was removed with a rotary evaporator. Dichloromethane was added and the mixture was filtered. The solvent from the filtrate was removed with a rotary evaporator. The residue was purified by medium pressure liquid chromatography (MPLC) (35→100% ethyl acetate in hexanes as eluant) to afford the title compound as a white solid (4.67 g).

$^1$H NMR ($CDCl_3$) δ 6.55 (s, 1H), 5.10 (s, 1H), 3.61 (m, 4H), 1.91 (m, 1H), 1.23 (m, 8H), 1.09 (m, 2H).

Additionally 3.24 g of an undehydrated product was obtained. This material could be converted to the title compound by refluxing it in methanol with a catalytic amount of pyridinium *p*-toluenesulfonate.

Step B: Preparation of ethyl 5-bromo-2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylate

To a solution of 2-cyclopropyl-6-(diethoxymethyl)-4(1*H*)-pyrimidinone (i.e. the title product of Step A) (2.9 g, 12.1 mmol) in dichloromethane (75 mL) was added *N*-bromosuccinimide (4.76 g, 26.8 mmol). The reaction mixture was stirred overnight. The solvent was removed with a rotary evaporator. The residue was purified by MPLC (1→4% methanol in dichloromethane as eluant) to afford the title compound as a white solid (2.68 g).

$^1$H NMR ($CDCl_3$) δ 4.43 (q, 2H), 1.90 (m, 1H), 1.41 (t, 3H), 1.30 (m, 2H), 1.20 (m, 2H).

Step C: Preparation of ethyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate and methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate

To a solution of ethyl 5-bromo-2-cyclopropyl-1,6-dihydro-6-oxo-4-pyrimidinecarboxylate (i.e. the product of Step B) (1.07 g, 3.7 mmol) in *N,N*-dimethylformamide (15 mL) was added thionyl chloride (0.54 mL, 7.5 mmol). The reaction mixture was stirred for 2 h. The solvent was removed with a rotary evaporator. The residue was dissolved in dichloromethane, washed with saturated aqueous sodium bicarbonate and dried ($Na_2SO_4$). The solvent was removed with a rotary evaporator. The residue was dissolved in tetrahydrofuran (2 mL), and a methanolic solution of ammonia (7 N, 2 mL) was added. The reaction mixture was placed in a sealed vial and heated in a microwave reactor at 125 °C for 2h. The reaction mixture was allowed to stand over the weekend. Dichloromethane was added and the reaction mixture was filtered. The solvent was removed with a rotary evaporator. The residue was purified by MPLC (10→30% ethyl acetate in hexanes as eluant) to afford the title product, a compound of the present invention, as a white solid (0.52 g).

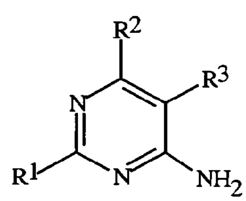
$^1$H NMR ($CDCl_3$) δ 5.40 (br s, 2H), 4.44 (q, 2H), 2.05 (m, 1H), 1.01 (t, 3H), 1.05 (m, 2H), 0.99 (m, 2H).

Also isolated by from the MPLC purification was the corresponding methyl ester, i.e. methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate, a further compound of the present invention, as a white solid (0.06 g).

$^1$H NMR ($CDCl_3$) δ 5.40 (br s, 2H), 3.97 (s, 3H) 2.05 (m, 1H), 1.05 (m, 2H), 0.99 (m, 2H).

By the procedures described herein together with methods known in the art, the following compounds of Tables 1 to 4 can be prepared. The following abbreviations are used in the Tables which follow: *t* means tertiary, *i* means iso, Me means methyl, Et means ethyl, Pr means propyl, *i*-Pr means isopropyl, Bu means butyl, *t*-Bu means *tert*-butyl, CN means cyano, and $S(O)_2Me$ means methylsulfonyl.

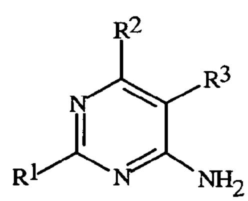
TABLE 1




| $R^1$ is cyclopropyl; $R^3$ is Cl. | $R^1$ is cyclopropyl; $R^3$ is F. | $R^1$ is cyclopropyl; $R^3$ is Br. | $R^1$ is cyclopropyl; $R^3$ is I. |
|---|---|---|---|
| $R^2$ | $R^2$ | $R^2$ | $R^2$ |
| $CO_2H$ | $CO_2H$ | $CO_2H$ | $CO_2H$ |
| $CO_2Me$ | $CO_2Me$ | $CO_2Me$ | $CO_2Me$ |

| $R^1$ is cyclopropyl; $R^3$ is Cl. | $R^1$ is cyclopropyl; $R^3$ is F. | $R^1$ is cyclopropyl; $R^3$ is Br. | $R^1$ is cyclopropyl; $R^3$ is I. |
|---|---|---|---|
| $R^2$ | $R^2$ | $R^2$ | $R^2$ |
| $CO_2Et$ | $CO_2Et$ | $CO_2Et$ | $CO_2Et$ |
| $CO_2Pr$ | $CO_2Pr$ | $CO_2Pr$ | $CO_2Pr$ |
| $CO_2i$Pr | $CO_2i$Pr | $CO_2i$Pr | $CO_2i$Pr |
| $CO_2t$-Bu | $CO_2t$-Bu | $CO_2t$-Bu | $CO_2t$-Bu |
| $CO_2$cyclohexyl | $CO_2$cyclohexyl | $CO_2$cyclohexyl | $CO_2$cyclohexyl |
| $CO_2$hexyl | $CO_2$hexyl | $CO_2$hexyl | $CO_2$hexyl |
| $CO_2CH_2$cyclohexyl | $CO_2CH_2$cyclohexyl | $CO_2CH_2$cyclohexyl | $CO_2CH_2$cyclohexyl |
| $CO_2CH_2Ph$ | $CO_2CH_2Ph$ | $CO_2CH_2Ph$ | $CO_2CH_2Ph$ |
| $CO_2CH(Me)Ph$ | $CO_2CH(Me)Ph$ | $CO_2CH(Me)Ph$ | $CO_2CH(Me)Ph$ |
| $CO_2CH_2$(4-Cl-Ph) | $CO_2CH_2$(4-Cl-Ph) | $CO_2CH_2$(4-Cl-Ph) | $CO_2CH_2$(4-Cl-Ph) |
| $CO_2CH_2$(3-F-Ph) | $CO_2CH_2$(3-F-Ph) | $CO_2CH_2$(3-F-Ph) | $CO_2CH_2$(3-F-Ph) |
| $CO_2CH_2CH_2NMe_2$ | $CO_2CH_2CH_2NMe_2$ | $CO_2CH_2CH_2NMe_2$ | $CO_2CH_2CH_2NMe_2$ |
| $CO_2CH_2CH_2OMe$ | $CO_2CH_2CH_2OMe$ | $CO_2CH_2CH_2OMe$ | $CO_2CH_2CH_2OMe$ |
| $CO_2CH_2$(3-oxetanyl) | $CO_2CH_2$(3-oxetanyl) | $CO_2CH_2$(3-oxetanyl) | $CO_2CH_2$(3-oxetanyl) |
| $CH_2OH$ | $CH_2OH$ | $CH_2OH$ | $CH_2OH$ |
| $CH_2OMe$ | $CH_2OMe$ | $CH_2OMe$ | $CH_2OMe$ |
| CHO | CHO | CHO | CHO |
| C(=NOH)H | C(=NOH)H | C(=NOH)H | C(=NOH)H |
| C(=NOMe)H | C(=NOMe)H | C(=NOMe)H | C(=NOMe)H |
| $CH_2CO_2Me$ | $CH_2CO_2Me$ | $CH_2CO_2Me$ | $CH_2CO_2Me$ |
| $C(=O)NH_2$ | $C(=O)NH_2$ | $C(=O)NH_2$ | $C(=O)NH_2$ |
| C(=O)NHMe | C(=O)NHMe | C(=O)NHMe | C(=O)NHMe |
| $C(=O)NMe_2$ | $C(=O)NMe_2$ | $C(=O)NMe_2$ | $C(=O)NMe_2$ |

## TABLE 2



| $R^2$ is $CO_2H$; $R^3$ is Cl. | $R^2$ is $CO_2Me$; $R^3$ is Cl. | $R^2$ is $CO_2Et$; $R^3$ is Cl. |
|---|---|---|
| $R^1$ | $R^1$ | $R^1$ |
| *i*-Pr | *i*-Pr | *i*-Pr |
| 1-Me-cyclopropyl | 1-Me-cyclopropyl | 1-Me-cyclopropyl |
| 2-Me-cyclopropyl | 2-Me-cyclopropyl | 2-Me-cyclopropyl |

$R^2$ is $CO_2H$; $R^3$ is Cl.

<u>$R^1$</u>

2-F-cyclopropyl
2-Cl-cyclopropyl
2,2-di-F-cyclopropyl
2,2-di-Cl-cyclopropyl
2,3-di-F-cyclopropyl
2,2,3,3-tetra-F-cyclopropyl
1,2,2,3,3-penta-F-cyclopropyl
Ph
4-Cl-Ph
4-F-Ph
3-OMe-Ph
Cl
OMe
OEt
OPh
O(3-Cl-Ph)
O(3,5-di-Cl-Ph)
SMe
SEt
NHMe
$NMe_2$
1-aziridinyl

$R^2$ is $CO_2Me$; $R^3$ is Cl.

<u>$R^1$</u>

2-F-cyclopropyl
2-Cl-cyclopropyl
2,2-di-F-cyclopropyl
2,2-di-Cl-cyclopropyl
1,2-di-F-cyclopropyl
2,2,3,3-tetra-F-cyclopropyl
1,2,2,3,3-penta-F-cyclopropyl
Ph
4-Cl-Ph
4-F-Ph
3-OMe-Ph
Cl
OMe
OEt
OPh
O(3-Cl-Ph)
O(3,5-di-Cl-Ph)
SMe
SEt
NHMe
$NMe_2$
1-aziridinyl

$R^2$ is $CO_2Et$; $R^3$ is Cl.

<u>$R^1$</u>

2-F-cyclopropyl
2-Cl-cyclopropyl
2,2-di-F-cyclopropyl
2,2-di-Cl-cyclopropyl
1,2-di-F-cyclopropyl
2,2,3,3-tetra-F-cyclopropyl
1,2,2,3,3-penta-F-cyclopropyl
Ph
4-Cl-Ph
4-F-Ph
3-OMe-Ph
Cl
OMe
OEt
OPh
O(3-Cl-Ph)
O(3,5-di-Cl-Ph)
SMe
SEt
NHMe
$NMe_2$
1-aziridinyl

$R^2$ is $CO_2H$; $R^3$ is Br.

<u>$R^1$</u>

*i*-Pr
1-Me-cyclopropyl
2-Me-cyclopropyl
2-F-cyclopropyl
2-Cl-cyclopropyl
2,2-di-F-cyclopropyl
2,2-di-Cl-cyclopropyl
1,2-di-F-cyclopropyl
2,2,3,3-tetra-F-cyclopropyl
1,2,2,3,3-penta-F-cyclopropyl
Ph

$R^2$ is $CO_2Me$; $R^3$ is Br.

<u>$R^1$</u>

*i*-Pr
1-Me-cyclopropyl
2-Me-cyclopropyl
2-F-cyclopropyl
2-Cl-cyclopropyl
2,2-di-F-cyclopropyl
2,2-di-Cl-cyclopropyl
1,2-di-F-cyclopropyl
2,2,3,3-tetra-F-cyclopropyl
1,2,2,3,3-penta-F-cyclopropyl
Ph

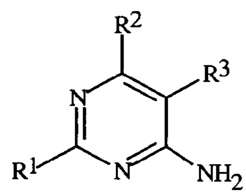
$R^2$ is $CO_2Et$; $R^3$ is Br.

<u>$R^1$</u>

*i*-Pr
1-Me-cyclopropyl
2-Me-cyclopropyl
2-F-cyclopropyl
2-Cl-cyclopropyl
2,2-di-F-cyclopropyl
2,2-di-Cl-cyclopropyl
1,2-di-F-cyclopropyl
2,2,3,3-tetra-F-cyclopropyl
1,2,2,3,3-penta-F-cyclopropyl
Ph

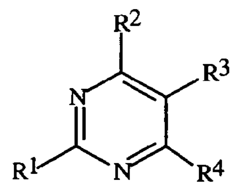
| $R^2$ is $CO_2H$; $R^3$ is Br. | $R^2$ is $CO_2Me$; $R^3$ is Br. | $R^2$ is $CO_2Et$; $R^3$ is Br. |
|---|---|---|
| <u>$R^1$</u> | <u>$R^1$</u> | <u>$R^1$</u> |
| 4-Cl-Ph | 4-Cl-Ph | 4-Cl-Ph |
| 4-F-Ph | 4-F-Ph | 4-F-Ph |
| 3-OMe-Ph | 3-OMe-Ph | 3-OMe-Ph |
| Cl | Cl | Cl |
| OMe | OMe | OMe |
| OEt | OEt | OEt |
| OPh | OPh | OPh |
| O(3-Cl-Ph) | O(3-Cl-Ph) | O(3-Cl-Ph) |
| O(3,5-di-Cl-Ph) | O(3,5-di-Cl-Ph) | O(3,5-di-Cl-Ph) |
| SEt | SEt | SEt |
| NHMe | NHMe | NHMe |
| $NMe_2$ | $NMe_2$ | $NMe_2$ |
| 1-aziridinyl | 1-aziridinyl | 1-aziridinyl |

<u>TABLE 3</u>




| $R^1$ is cyclopropyl; $R^2$ is $CO_2Me$. | $R^1$ is cyclopropyl; $R^2$ is $CO_2Et$. |
|---|---|
| <u>$R^3$</u> | <u>$R^3$</u> |
| CN | CN |
| $NO_2$ | $NO_2$ |
| OMe | OMe |
| SMe | SMe |
| $NH_2$ | $NH_2$ |
| NHMe | NHMe |
| $NMe_2$ | $NMe_2$ |

TABLE 4



| $R^1$ is cyclopropyl; $R^2$ is $CO_2Me$; $R^3$ is Cl. | $R^1$ is cyclopropyl; $R^2$ is $CO_2Me$; $R^3$ is Br. | $R^1$ is cyclopropyl; $R^2$ is $CO_2Et$; $R^3$ is Cl. | $R^1$ is cyclopropyl; $R^2$ is $CO_2Et$; $R^3$ is Br. |
|---|---|---|---|
| $R^4$ | $R^4$ | $R^4$ | $R^4$ |
| $NO_2$ | $NO_2$ | $NO_2$ | $NO_2$ |
| NHMe | NHMe | NHMe | NHMe |
| $NMe_2$ | $NMe_2$ | $NMe_2$ | $NMe_2$ |
| $N(-CH_2CH_2OCH_2CH_2-)$ | $N(-CH_2CH_2OCH_2CH_2-)$ | $N(-CH_2CH_2OCH_2CH_2-)$ | $N(-CH_2CH_2OCH_2CH_2-)$ |
| NHC(=O)Me | NHC(=O)Me | NHC(=O)Me | NHC(=O)Me |
| NHC(=O)OMe | NHC(=O)OMe | NHC(=O)OMe | NHC(=O)OMe |
| $NHS(O)_2Me$ | $NHS(O)_2Me$ | $NHS(O)_2Me$ | $NHS(O)_2Me$ |
| $NHNH_2$ | $NHNH_2$ | $NHNH_2$ | $NHNH_2$ |
| $NHNO_2$ | $NHNO_2$ | $NHNO_2$ | $NHNO_2$ |
| $N{=}CHNMe_2$ | $N{=}CHNMe_2$ | $N{=}CHNMe_2$ | $N{=}CHNMe_2$ |
| NHOH | NHOH | NHOH | NHOH |
| NHOMe | NHOMe | NHOMe | NHOMe |
| $NHCH_2CO_2Me$ | $NHCH_2CO_2Me$ | $NHCH_2CO_2Me$ | $NHCH_2CO_2Me$ |
| $NHCH_2CO_2Et$ | $NHCH_2CO_2Et$ | $NHCH_2CO_2Et$ | $NHCH_2CO_2Et$ |
| $NHCH_2CH_2OH$ | $NHCH_2CH_2OH$ | $NHCH_2CH_2OH$ | $NHCH_2CH_2OH$ |
| $NHCH_2CH_2OMe$ | $NHCH_2CH_2OMe$ | $NHCH_2CH_2OMe$ | $NHCH_2CH_2OMe$ |
| $NHCH_2CH_2NMe_2$ | $NHCH_2CH_2NMe_2$ | $NHCH_2CH_2NMe_2$ | $NHCH_2CH_2NMe_2$ |

Formulation/Utility

Compounds of this invention will generally be used as a formulation or composition with an agriculturally suitable carrier comprising at least one of a liquid diluent, a solid diluent or a surfactant. The formulation or composition ingredients are selected to be consistent with the physical properties of the active ingredient, mode of application and environmental factors such as soil type, moisture and temperature. Useful formulations include liquids such as solutions (including emulsifiable concentrates), suspensions, emulsions (including microemulsions and/or suspoemulsions) and the like which optionally can be thickened into gels. Useful formulations further include solids such as dusts, powders, granules, pellets, tablets, films (including seed coatings), and the like which can be water-dispersible ("wettable") or water-soluble. Active ingredient can be (micro)encapsulated and further formed into a suspension or solid formulation; alternatively

the entire formulation of active ingredient can be encapsulated (or "overcoated"). Encapsulation can control or delay release of the active ingredient. Sprayable formulations can be extended in suitable media and used at spray volumes from about one to several hundred liters per hectare. High-strength compositions are primarily used as intermediates for further formulation.

The formulations will typically contain effective amounts of active ingredient, diluent and surfactant within the following approximate ranges which add up to 100 percent by weight.

| | Weight Percent | | |
|---|---|---|---|
| | Active Ingredient | Diluent | Surfactant |
| Water-Dispersible and Water-soluble Granules, Tablets and Powders. | 0.001–90 | 0–99.999 | 0–15 |
| Suspensions, Emulsions, Solutions (including Emulsifiable Concentrates) | 1–50 | 40–99 | 0–50 |
| Dusts | 1–25 | 70–99 | 0–5 |
| Granules and Pellets | 0.001–99 | 5–99.999 | 0–15 |
| High Strength Compositions | 90–99 | 0–10 | 0–2 |

Typical solid diluents are described in Watkins, et al., *Handbook of Insecticide Dust Diluents and Carriers*, 2nd Ed., Dorland Books, Caldwell, New Jersey. Typical liquid diluents are described in Marsden, *Solvents Guide*, 2nd Ed., Interscience, New York, 1950. *McCutcheon's Detergents and Emulsifiers Annual*, Allured Publ. Corp., Ridgewood, New Jersey, as well as Sisely and Wood, *Encyclopedia of Surface Active Agents*, Chemical Publ. Co., Inc., New York, 1964, list surfactants and recommended uses. All formulations can contain minor amounts of additives to reduce foam, caking, corrosion, microbiological growth and the like, or thickeners to increase viscosity.

Surfactants include, for example, polyethoxylated alcohols, polyethoxylated alkylphenols, polyethoxylated sorbitan fatty acid esters, dialkyl sulfosuccinates, alkyl sulfates, alkylbenzene sulfonates, organosilicones, *N,N*-dialkyltaurates, lignin sulfonates, naphthalene sulfonate formaldehyde condensates, polycarboxylates, glycerol esters, polyoxyethylene/polyoxypropylene block copolymers, and alkylpolyglycosides where the number of glucose units, referred to as degree of polymerization (D.P.), can range from 1 to 3 and the alkyl units can range from $C_6$ to $C_{14}$ (see *Pure and Applied Chemistry 72*, 1255–1264). Solid diluents include, for example, clays such as bentonite, montmorillonite, attapulgite and kaolin, starch, sugar, silica, talc, diatomaceous earth, urea, calcium carbonate, sodium carbonate and bicarbonate, and sodium sulfate. Liquid diluents include, for example,

water, *N,N*-dimethylformamide, dimethyl sulfoxide, *N*-alkylpyrrolidone, ethylene glycol, polypropylene glycol, propylene carbonate, dibasic esters, paraffins, alkylbenzenes, alkylnaphthalenes, glycerine, triacetine, oils of olive, castor, linseed, tung, sesame, corn, peanut, cotton-seed, soybean, rape-seed and coconut, fatty acid esters, ketones such as cyclohexanone, 2-heptanone, isophorone and 4-hydroxy-4-methyl-2-pentanone, acetates such as hexyl acetate, heptyl acetate and octyl acetate, and alcohols such as methanol, cyclohexanol, decanol, benzyl and tetrahydrofurfuryl alcohol.

Useful formulations of this invention may also contain materials well known to those skilled in the art as formulation aids such as antifoams, film formers and dyes. Antifoams can include water dispersible liquids comprising polyorganosiloxanes like Rhodorsil® 416. The film formers can include polyvinyl acetates, polyvinyl acetate copolymers, polyvinylpyrrolidone-vinyl acetate copolymer, polyvinyl alcohols, polyvinyl alcohol copolymers and waxes. Dyes can include water dispersible liquid colorant compositions like Pro-lzed® Colorant Red. One skilled in the art will appreciate that this is a non-exhaustive list of formulation aids. Suitable examples of formulation aids include those listed herein and those listed in *McCutcheon's 2001, Volume 2: Functional Materials* published by MC Publishing Company and PCT Publication WO 03/024222.

Solutions, including emulsifiable concentrates, can be prepared by simply mixing the ingredients. Dusts and powders can be prepared by blending and, usually, grinding as in a hammer mill or fluid-energy mill. Suspensions are usually prepared by wet-milling; see, for example, U.S. 3,060,084. Granules and pellets can be prepared by spraying the active material upon preformed granular carriers or by agglomeration techniques. See Browning, "Agglomeration", *Chemical Engineering*, December 4, 1967, pp 147–48, *Perry's Chemical Engineer's Handbook*, 4th Ed., McGraw-Hill, New York, 1963, pages 8–57 and following, and WO 91/13546. Pellets can be prepared as described in U.S. 4,172,714. Water-dispersible and water-soluble granules can be prepared as taught in U.S. 4,144,050, U.S. 3,920,442 and DE 3,246,493. Tablets can be prepared as taught in U.S. 5,180,587, U.S. 5,232,701 and U.S. 5,208,030. Films can be prepared as taught in GB 2,095,558 and U.S. 3,299,566.

For further information regarding the art of formulation, see T. S. Woods, "The Formulator's Toolbox – Product Forms for Modern Agriculture" in *Pesticide Chemistry and Bioscience, The Food–Environment Challenge*, T. Brooks and T. R. Roberts, Eds., Proceedings of the 9th International Congress on Pesticide Chemistry, The Royal Society of Chemistry, Cambridge, 1999, pp. 120–133. See also U.S. 3,235,361, Col. 6, line 16 through Col. 7, line 19 and Examples 10–41; U.S. 3,309,192, Col. 5, line 43 through Col. 7, line 62 and Examples 8, 12, 15, 39, 41, 52, 53, 58, 132, 138–140, 162–164, 166, 167 and 169–182; U.S. 2,891,855, Col. 3, line 66 through Col. 5, line 17 and Examples 1–4; Klingman, *Weed Control as a Science*, John Wiley and Sons, Inc., New York, 1961, pp 81–96; Hance et al.,

*Weed Control Handbook*, 8th Ed., Blackwell Scientific Publications, Oxford, 1989; and *Developments in formulation technology*, PJB Publications, Richmond, UK, 2000.

In the following Examples, all percentages are by weight and all formulations are prepared in conventional ways. Compound numbers refer to compounds in Index Tables A–B.

Example A

High Strength Concentrate

| | |
|---|---|
| Compound 1 | 98.5% |
| silica aerogel | 0.5% |
| synthetic amorphous fine silica | 1.0%. |

Example B

Wettable Powder

| | |
|---|---|
| Compound 2 | 65.0% |
| dodecylphenol polyethylene glycol ether | 2.0% |
| sodium ligninsulfonate | 4.0% |
| sodium silicoaluminate | 6.0% |
| montmorillonite (calcined) | 23.0%. |

Example C

Granule

| | |
|---|---|
| Compound 4 | 10.0% |
| attapulgite granules (low volatile matter, 0.71/0.30 mm; U.S.S. No. 25–50 sieves) | 90.0%. |

Example D

Aqueous Suspension

| | |
|---|---|
| Compound 9 | 25.0% |
| hydrated attapulgite | 3.0% |
| crude calcium ligninsulfonate | 10.0% |
| sodium dihydrogen phosphate | 0.5% |
| water | 61.5%. |

Example E

Extruded Pellet

| | |
|---|---|
| Compound 1 | 25.0% |
| anhydrous sodium sulfate | 10.0% |
| crude calcium ligninsulfonate | 5.0% |
| sodium alkylnaphthalenesulfonate | 1.0% |
| calcium/magnesium bentonite | 59.0%. |

Example F

Microemulsion

| | |
|---|---|
| Compound 2 | 1.0% |
| triacetine | 30.0% |
| $C_8$–$C_{10}$ alkylpolyglycoside | 30.0% |
| glyceryl monooleate | 19.0% |
| water | 20.0%. |

Test results indicate that the compounds of the present invention are highly active preemergent and/or postemergent herbicides and/or plant growth regulants. Many of them have utility for broad-spectrum pre- and/or postemergence weed control in areas where complete control of all vegetation is desired such as around fuel storage tanks, industrial storage areas, parking lots, drive-in theaters, air fields, river banks, irrigation and other waterways, around billboards and highway and railroad structures. Many of the compounds of this invention, by virtue of selective metabolism in crops versus weeds, or by selective activity at the locus of physiological inhibition in crops and weeds, or by selective placement on or within the environment of a mixture of crops and weeds, are useful for the selective control of grass and broadleaf weeds within a crop/weed mixture. One skilled in the art will recognize that the preferred combination of these selectivity factors within a compound or group of compounds can readily be determined by performing routine biological and/or biochemical assays. Compounds of this invention may show tolerance to important agronomic crops including, but is not limited to, alfalfa, barley, cotton, wheat, rape, sugar beets, corn (maize), sorghum, soybeans, rice, oats, peanuts, vegetables, tomato, potato, perennial plantation crops including coffee, cocoa, oil palm, rubber, sugarcane, citrus, grapes, fruit trees, nut trees, banana, plantain, pineapple, hops, tea and forests such as eucalyptus and conifers (e.g., loblolly pine), and turf species (e.g., Kentucky bluegrass, St. Augustine grass, Kentucky fescue and Bermuda grass). Those skilled in the art will appreciate that not all compounds are equally effective against all weeds. Alternatively, the subject compounds are useful to modify plant growth.

As the compounds of the invention have both preemergent and postemergent herbicidal activity, to control undesired vegetation by killing or injuring the vegetation or reducing its growth, the compounds can be usefully applied by a variety of methods involving contacting a herbicidally effective amount of a compound of the invention, or a composition comprising said compound and at least one of a surfactant, a solid diluent or a liquid diluent, to the foliage or other part of the undesired vegetation or to the environment of the undesired vegetation such as the soil or water in which the undesired vegetation is growing or which surrounds the seed or other propagule of the undesired vegetation.

A herbicidally effective amount of the compounds of this invention is determined by a number of factors. These factors include: formulation selected, method of application,

amount and type of vegetation present, growing conditions, etc. In general, a herbicidally effective amount of compounds of this invention is about 0.0001 to 20 kg/ha with a preferred range of about 0.001 to 5 kg/ha and a more preferred range of about 0.004 to 3 kg/ha. One skilled in the art can easily determine the herbicidally effective amount necessary for the desired level of weed control.

Compounds of this invention can be used alone or in combination with other commercial herbicides, insecticides and fungicides, and other agricultural chemicals such as fertilizers. Mixtures of the compounds of the invention with other herbicides can broaden the spectrum of activity against additional weed species, and suppress the proliferation of any resistant biotypes. A mixture of one or more of the following herbicides with a compound of this invention may be particularly useful for weed control: acetochlor, acifluorfen and its sodium salt, aclonifen, acrolein (2-propenal), alachlor, alloxydim, ametryn, amicarbazone, amidosulfuron, aminopyralid, amitrole, ammonium sulfamate, anilofos, asulam, atrazine, azimsulfuron, beflubutamid, benazolin, benazolin-ethyl, benfluralin, benfuresate, bensulfuron-methyl, bensulide, bentazone, benzobicyclon, benzofenap, bifenox, bilanafos, bispyribac and its sodium salt, bromacil, bromobutide, bromofenoxim, bromoxynil, bromoxynil octanoate, butachlor, butafenacil, butamifos, butralin, butroxydim, butylate, cafenstrole, carbetamide, carfentrazone-ethyl, catechin, chlomethoxyfen, chloramben, chlorbromuron, chlorflurenol-methyl, chloridazon, chlorimuron-ethyl, chlorotoluron, chlorpropham, chlorsulfuron, chlorthal-dimethyl, chlorthiamid, cinidon-ethyl, cinmethylin, cinosulfuron, clethodim, clodinafop-propargyl, clomazone, clomeprop, clopyralid, clopyralid-olamine, cloransulam-methyl, cumyluron, cyanazine, cycloate, cyclosulfamuron, cycloxydim, cyhalofop-butyl, 2,4-D and its butotyl, butyl, isoctyl and isopropyl esters and its dimethylammonium, diolamine and trolamine salts, daimuron, dalapon, dalapon-sodium, dazomet, 2,4-DB and its dimethylammonium, potassium and sodium salts, desmedipham, desmetryn, dicamba and its diglycolammonium, dimethylammonium, potassium and sodium salts, dichlobenil, dichlorprop, diclofop-methyl, diclosulam, difenzoquat metilsulfate, diflufenican, diflufenzopyr, dimefuron, dimepiperate, dimethachlor, dimethametryn, dimethenamid, dimethenamid-P, dimethipin, dimethylarsinic acid and its sodium salt, dinitramine, dinoterb, diphenamid, diquat dibromide, dithiopyr, diuron, DNOC, endothal, EPTC, esprocarb, ethalfluralin, ethametsulfuron-methyl, ethofumesate, ethoxyfen, ethoxysulfuron, etobenzanid, fenoxaprop-ethyl, fenoxaprop-P-ethyl, fentrazamide, fenuron, fenuron-TCA, flamprop-methyl, flamprop-M-isopropyl, flamprop-M-methyl, flazasulfuron, florasulam, fluazifop-butyl, fluazifop-P-butyl, flucarbazone, fluchloralin, flufenacet, flufenpyr, flufenpyr-ethyl, flumetsulam, flumiclorac-pentyl, flumioxazin, fluometuron, fluoroglycofen-ethyl, flupyrsulfuron-methyl and its sodium salt, flurenol, flurenol-butyl, fluridone, flurochloridone, fluroxypyr, flurtamone, fluthiacet-methyl, fomesafen, foramsulfuron, fosamine-ammonium, glufosinate,

glufosinate-ammonium, glyphosate and its salts such as ammonium, isopropylammonium, potassium, sodium (including sesquisodium) and trimesium (alternatively named sulfosate), halosulfuron-methyl, haloxyfop-etotyl, haloxyfop-methyl, hexazinone, imazamethabenz-methyl, imazamox, imazapic, imazapyr, imazaquin, imazaquin-ammonium, imazethapyr, imazethapyr-ammonium, imazosulfuron, indanofan, iodosulfuron-methyl, ioxynil, ioxynil octanoate, ioxynil-sodium, isoproturon, isouron, isoxaben, isoxaflutole, isoxachlortole, isoxadifen, lactofen, lenacil, linuron, maleic hydrazide, MCPA and its dimethylammonium, potassium and sodium salts, MCPA-isoctyl, MCPA-thioethyl, MCPB and its sodium salt, MCPB-ethyl, mecoprop, mecoprop-P, mefenacet, mefluidide, mesosulfuron-methyl, mesotrione, metam-sodium, metamifop, metamitron, metazachlor, methabenzthiazuron, methylarsonic acid and its calcium, monoammonium, monosodium and disodium salts, methyldymron, metobenzuron, metobromuron, metolachlor, S-metholachlor, metosulam, metoxuron, metribuzin, metsulfuron-methyl, molinate, monolinuron, naproanilide, napropamide, naptalam, neburon, nicosulfuron, norflurazon, orbencarb, oryzalin, oxadiargyl, oxadiazon, oxasulfuron, oxaziclomefone, oxyfluorfen, paraquat dichloride, pebulate, pelargonic acid, pendimethalin, penoxsulam, pentanochlor, pentoxazone, perfluidone, pethoxyamid, phenmedipham, picloram, picloram-potassium, picolinafen, piperofos, pretilachlor, primisulfuron-methyl, prodiamine, profoxydim, prometon, prometryn, propachlor, propanil, propaquizafop, propazine, propham, propisochlor, propoxycarbazone, propyzamide, prosulfocarb, prosulfuron, pyraclonil, pyraflufen-ethyl, pyrazogyl, pyrazolynate, pyrazoxyfen, pyrazosulfuron-ethyl, pyribenzoxim, pyributicarb, pyridate, pyriftalid, pyriminobac-methyl, pyrithiobac, pyrithiobac-sodium, quinclorac, quinmerac, quinoclamine, quizalofop-ethyl, quizalofop-P-ethyl, quizalofop-P-tefuryl, rimsulfuron, sethoxydim, siduron, simazine, simetryn, sulcotrione, sulfentrazone, sulfometuron-methyl, sulfosulfuron, 2,3,6-TBA, TCA, TCA-sodium, tebutam, tebuthiuron, tepraloxydim, terbacil, terbumeton, terbuthylazine, terbutryn, thenylchlor, thiazopyr, thifensulfuron-methyl, thiobencarb, tiocarbazil, tralkoxydim, tri-allate, triasulfuron, triaziflam, tribenuron-methyl, triclopyr, triclopyr-butotyl, triclopyr-triethylammonium, tridiphane, trietazine, trifloxysulfuron, trifluralin, triflusulfuron-methyl, tritosulfuron and vernolate. Other herbicides also include bioherbicides such as *Alternaria destruens* Simmons, *Colletotrichum gloeosporiodes* (Penz.) Penz. & Sacc., *Drechsiera monoceras* (MTB-951), *Myrothecium verrucaria* (Albertini & Schweinitz) Ditmar: Fries, *Phytophthora palmivora* (Butl.) Butl. and *Puccinia thlaspeos* Schub. Combinations of compounds of the invention with other herbicides can result in a greater-than-additive (i.e. synergistic) effect on weeds and/or a less-than-additive effect (i.e. safening) on crops or other desirable plants. In certain instances, combinations with other herbicides having a similar spectrum of control but a different mode of action will be particularly advantageous for preventing the development of resistant weeds. Herbicidally

effective amounts of compounds of the invention as well as herbicidally effective amounts of other herbicides can be easily determined by one skilled in the art through simple experimentation.

Preferred for better control of undesired vegetation (e.g., lower use rate, broader spectrum of weeds controlled, or enhanced crop safety) or for preventing the development of resistant weeds are mixtures of a compound of this invention with a herbicide selected from the group consisting of ametryn, diuron, flupyrsulfuron-methyl (particularly flupyrsulfuron-methyl-sodium), glyphosate (particularly glyphosate-isopropylammonium, glyphosate-sodium, glyphosate-potassium, glyphosate-trimesium), glufosinate (particularly glufosinate-ammonium), hexazinone, isoproturon, metsulfuron-methyl, rimsulfuron, sulfometuron-methyl, terbacil, and paraquat. Specifically preferred mixtures (compound numbers refer to compounds in Index Tables A–B) are selected from the group: compound 1 and ametryn; compound 2 and ametryn; compound 4 and ametryn; compound 5 and ametryn; compound 9 and ametryn; compound 15 and ametryn; compound 16 and ametryn; compound 17 and ametryn; compound 1 and diuron; compound 2 and diuron; compound 4 and diuron; compound 5 and diuron; compound 9 and diuron; compound 15 and diuron; compound 16 and diuron; compound 17 and diuron; compound 1 and flupyrsulfuron-methyl; compound 2 and flupyrsulfuron-methyl; compound 4 and flupyrsulfuron-methyl; compound 5 and flupyrsulfuron-methyl; compound 9 and flupyrsulfuron-methyl; compound 15 and flupyrsulfuron-methyl; compound 16 and flupyrsulfuron-methyl; compound 17 and flupyrsulfuron-methyl; compound 1 and glyphosate; compound 2 and glyphosate; compound 4 and glyphosate; compound 5 and glyphosate; compound 9 and glyphosate; compound 15 and glyphosate; compound 16 and glyphosate; compound 17 and glyphosate; compound 1 and glufosinate; compound 2 and glufosinate; compound 4 and glufosinate; compound 5 and glufosinate; compound 9 and glufosinate; compound 15 and glufosinate; compound 16 and glufosinate; compound 17 and glufosinate; compound 1 and hexazinone; compound 2 and hexazinone; compound 4 and hexazinone; compound 5 and hexazinone; compound 9 and hexazinone; compound 15 and hexazinone; compound 16 and hexazinone; compound 17 and hexazinone; compound 1 and isoproturon; compound 2 and isoproturon; compound 4 and isoproturon; compound 5 and isoproturon; compound 9 and isoproturon; compound 15 and isoproturon; compound 16 and isoproturon; compound 17 and isoproturon; compound 1 and metsulfuron-methyl; compound 2 and metsulfuron-methyl; compound 4 and metsulfuron-methyl; compound 5 and metsulfuron-methyl; compound 9 and metsulfuron-methyl; compound 15 and metsulfuron-methyl; compound 16 and metsulfuron-methyl; compound 17 and metsulfuron-methyl; compound 1 and paraquat; compound 2 and paraquat; compound 4 and paraquat; compound 5 and paraquat; compound 9 and paraquat; compound 15 and paraquat; compound 16 and paraquat; compound 17 and paraquat; compound 1 and rimsulfuron; compound 2 and rimsulfuron;

compound 4 and rimsulfuron; compound 5 and rimsulfuron; compound 9 and rimsulfuron; compound 15 and rimsulfuron; compound 16 and rimsulfuron; compound 4 and rimsulfuron; compound 17 and sulfometuron-methyl; compound 2 and sulfometuron-methyl; compound 4 and sulfometuron-methyl; compound 5 and sulfometuron-methyl; compound 9 and sulfometuron-methyl; compound 15 and sulfometuron-methyl; compound 16 and sulfometuron-methyl; compound 17 and sulfometuron-methyl; compound 1 and terbacil; compound 2 and terbacil; compound 4 and terbacil; compound 5 and terbacil; compound 9 and terbacil; compound 15 and terbacil; compound 16 and terbacil; compound 17 and terbacil.

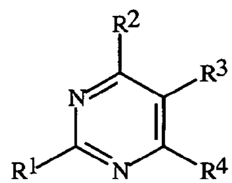
Compounds of this invention can also be used in combination with herbicide safeners such as benoxacor, BCS (1-bromo-4-[(chloromethyl)sulfonyl]benzene), cloquintocet-mexyl, cyometrinil, dichlormid, 2-(dichloromethyl)-2-methyl-1,3-dioxolane (MG 191), fenchlorazole-ethyl, fenclorim, flurazole, fluxofenim, furilazole, isoxadifen-ethyl, mefenpyr-ethyl, methoxyphenone ((4-methoxy-3-methylphenyl)(3-methylphenyl)methanone), naphthalic anhydride (1,8-naphthalic anhydride) and oxabetrinil to increase safety to certain crops. Antidotally effective amounts of the herbicide safeners can be applied at the same time as the compounds of this invention, or applied as seed treatments. Therefore an aspect of the present invention relates to a herbicidal mixture comprising a compound of this invention and an antidotally effective amount of a herbicide safener. Seed treatment is particularly useful for selective weed control, because it physically restricts antidoting to the crop plants. Therefore a particularly useful embodiment of the present invention is a method for selectively controlling the growth of undesired vegetation in a crop comprising contacting the locus of the crop with a herbicidally effective amount of a compound of this invention wherein seed from which the crop is grown is treated with an antidotally effective amount of safener. Antidotally effective amounts of safeners can be easily determined by one skilled in the art through simple experimentation.

Compounds of this invention can also be used in combination with plant growth regulators such as aviglycine, *N*-(phenylmethyl)-1*H*-purin-6-amine, epocholeone, gibberellic acid, gibberellin $A_4$ and $A_7$, harpin protein, mepiquat chloride, prohexadione calcium, prohydrojasmon, sodium nitrophenolate and trinexapac-methyl, and plant growth modifying organisms such as *Bacillus cereus* strain BP01.

The following Tests demonstrate the control efficacy of the compounds of this invention against specific weeds. The weed control afforded by the compounds is not limited, however, to these species. See Index Tables A–B for compound descriptions. The following abbreviations are used in the Index Tables which follow: *t* means tertiary, *s* means secondary, *n* means normal, *i* means iso, *c* means cyclo, Me means methyl, Et means ethyl, Pr means propyl, *i*-Pr means isopropyl, Bu means butyl, Ph means phenyl, MeO means methoxy, EtO means ethoxy, and CN means cyano. The abbreviation "dec." indicates that

the compound appeared to decompose on melting. The abbreviation "Ex." stands for "Example" and is followed by a number indicating in which example the compound is prepared.

INDEX TABLE A



| Compound | $R^1$ | $R^2$ | $R^3$ | $R^4$ | m.p. (°C) |
|---|---|---|---|---|---|
| 1 (Ex. 1) | *c*-Pr | $CO_2CH_2CH_3$ | Br | $NH_2$ | 107–108 |
| 2 (Ex. 1) | *c*-Pr | $CO_2CH_3$ | Br | $NH_2$ | 148–150 |
| 3 | *i*-Pr | $CO_2CH_3$ | Br | $NH_2$ | 107–109 |
| 4 | *c*-Pr | $CO_2CH_2CH_3$ | Cl | $NH_2$ | 87–89 |
| 5 | *c*-Pr | $CO_2CH_3$ | Br | $NHCH_3$ | * |
| 6 | Cl | $CO_2CH_3$ | Cl | $NH_2$ | 169–171 |
| 7 | *c*-Pr | $CO_2CH_3$ | I | $NH_2$ | 145–146 |
| 8 | *c*-Pr | $CO_2H$ | Br | $NH_2$ | 160–162 |
| 9 | *c*-Pr | $CO_2CH_3$ | Cl | $NH_2$ | 143–145 |
| 10 | *c*-Pr | $CO_2CH_3$ | Br | $NHCH_2CO_2CH_3$ | 95–96 |
| 11 | *c*-Pr | $CH_2OCH_3$ | Br | $NH_2$ | * |
| 12 | *c*-Pr | $CH_2CO_2CH_2CH_3$ | Br | $NH_2$ | * |
| 13 | *c*-Pr | $CH_2CO_2CH_3$ | Br | $NH_2$ | * |
| 14 | *c*-Pr | $CO_2$(*i*-Pr) | Br | $NH_2$ | 141–142 |
| 15 | *c*-Pr | $CO_2CH_2CH_2CH_3$ | Br | $NH_2$ | 86–90 |
| 16 | *c*-Pr | $CO_2CH_2CH_2CH_2CH_3$ | Br | $NH_2$ | 87–90 |
| 17 | *c*-Pr | $CO_2$(*i*-Bu) | Br | $NH_2$ | 121–123 |
| 18 | Ph | $CO_2CH_2CH_3$ | Br | $NH_2$ | 110–111 |
| 19 | *c*-Pr | $CO_2CH_3$ | Br | $N{=}CHN(CH_3)_2$ | * |
| 20 | *c*-Pr | $C(O)NH_2$ | Br | $NH_2$ | * |
| 21 | *c*-Pr | $CH_2OH$ | Br | $NH_2$ | 182–185 |
| 22 | *c*-Pr | $CO_2CH_2Ph$ | Br | $NH_2$ | 129–131 |
| 23 | Ph | $CO_2CH_3$ | Br | $NH_2$ | * |
| 24 | *c*-Pr | CHO | F | $NH_2$ | * |
| 25 | *c*-Pr | $CO_2CH_3$ | F | $NH_2$ | * |
| 26 | *c*-Pr | CHO | Br | $NH_2$ | * |
| 27 | *c*-Pr | CH(=NOH) | Br | $NH_2$ | * |

| Compound | $R^1$ | $R^2$ | $R^3$ | $R^4$ | m.p. (°C) |
|---|---|---|---|---|---|
| 28 | 2-Me-*c*-Pr | $CO_2CH_3$ | Br | $NH_2$ | 132–133 |
| 29 | $SCH_3$ | $CO_2CH_2CH_3$ | Cl | $NH_2$ | * |
| 30 | *c*-Pr | $CO_2CH_2CH_3$ | F | $NH_2$ | * |
| 31 | *c*-Pr | $CH(Cl)CO_2CH_2CH_3$ | Br | $NH_2$ | * |
| 32 | *c*-Pr | $CH(CH_3)CO_2CH_2CH_3$ | Br | $NH_2$ | * |
| 33 | *c*-Pr | $CH_2CO_2CH_2CH_3$ | Br | $N{=}CHN(CH_3)_2$ | * |
| 34 | *c*-Pr | $CCl_2CO_2CH_2CH_3$ | Br | $NH_2$ | * |
| 35 | *c*-Pr | $CO_2CH_3$ | Br | NHOH | * |
| 36 | *t*-Bu | $CO_2CH_2CH_3$ | Br | $NH_2$ | 69–70 |
| 37 | 4-Cl-Ph | $CO_2CH_2CH_3$ | Br | $NH_2$ | 120–121 |
| 38 | *c*-Pr | $CO_2CH_2CH_3$ | Br | $NHCH_2CH_2N(CH_3)_2$ | * |
| 39 | *c*-Pr | $CO_2CH_2CH_3$ | Br | $NHCH_2CH_2OCH_3$ | * |
| 40 | *c*-Pr | $CO_2CH_2CH_3$ | Br | $N{=}CHN(CH_3)_2$ | * |
| 41 | 4-Cl-Ph | $CH_2CO_2CH_2CH_3$ | Br | $NH_2$ | * |
| 42 | *c*-Pr | $CO_2CH_2CH_3$ | Br | $NHNH_2$ | * |
| 43 | 4-F-Ph | $CO_2CH_3$ | Cl | $NH_2$ | * |
| 44 | 4-$CF_3$-Ph | $CO_2CH_3$ | Cl | $NH_2$ | * |

* See Index Table B for $^1$H NMR data.

## INDEX TABLE B

| Compound | $^1$H NMR Data ($CDCl_3$ solution unless indicated otherwise)[a] |
|---|---|
| 5 | δ 5.60 (br s, 1H), 3.96 (s, 3H), 3.02 (d, 3H), 2.10 (m, 1H), 1.25 (t, 3H), 1.10 (m, 2H), 0.98 (m, 2H). |
| 11 | δ 5.20 (br s, 2H), 4.97 (s, 2H), 3.49 (s, 3H), 2.07 (m, 1H), 1.25 (t, 3H), 1.02 (m, 2H), 0.95 (m, 2H). |
| 12 | δ 5.20 (br s, 2H), 4.18 (q, 2H), 3.80 (s, 2H), 1.90 (m, 1H), 1.25 (t, 3H), 1.01–0.93 (m, 4H). |
| 13 | δ 5.26 (br s, 2H), 3.82 (s, 2H), 3.73 (s, 3H), 1.90 (m, 1H), 1.02–0.92 (m, 4H). |
| 19 | δ 8.60 (s, 1H), 3.97 (s, 3H), 3.20 (s, 3H), 3.19 (s, 3H), 2.10 (m, 1H), 1.08 (m, 2H), 0.99 (m, 2H). |
| 20 | δ 7.65 (br s, 1H), 5.94 (br s, 2H), 5.8 (br s, 1H), 2.01 (m, 1H), 1.03 (m, 4H). |
| 23 | δ 8.35 (m, 2H), 7.46 (m, 3H), 5.61 (br s, 2H), 4.02 (s, 3H). |
| 24 | δ 10.01 (s, 1H), 5.31 (br s, 2H), 2.10 (m, 1H), 1.10–0.95 (m, 4H). |
| 25 | δ 5.15 (br s, 2H), 3.98 (s, 3H), 2.03 (m, 1H), 1.04–0.92 (m, 4H). |
| 26 | δ 9.98 (s, 1H), 5.60 (br s, 2H), 2.10 (m, 1H), 1.10–1.02 (m, 4H). |
| 27 | δ 8.19 (s, 1H), 1.89 (m, 1H), 0.92-0.87 (m, 4H). |
| 29 | δ 5.55 (br s, 2H), 4.45 (q, 2H), 2.51 (s, 3H), 1.42 (t, 3H). |
| 30 | δ 5.12 (br s, 2H), 4.45 (q, 2H), 2.13 (m, 1H), 1.41 (t, 3H), 1.04–0.92 (m, 4H). |

| Compound | $^1$H NMR Data ($CDCl_3$ solution unless indicated otherwise)[a] |
|---|---|
| 31 | δ 5.66 (s, 1H), 5.34 (br s, 2H), 4.30 (q, 2H), 1.98 (m, 1H), 1.30 (t, 3H), 1.13–0.92 (m, 4H). |
| 32 | δ 5.26 (br s, 2H), 4.21–4.07 (m, 3H), 1.94 (m, 1H), 1.45 (d, 2H), 1.22 (t, 3H), 1.08–0.90 (m, 4H). |
| 33 | δ 8.57 (s, 1H), 4.18 (q, 2H), 3.88 (s, 2H), 3.18 (s, 3H), 3.16 (s, 3H), 2.00 (m, 1H), 1.24 (t, 3H), 1.05–0.96 (m, 4H). |
| 34 | δ 5.48 (br s, 2H), 4.38 (q, 2H), 2.02 (m, 1H), 1.36 (t, 3H), 1.11–0.97(m, 4H). |
| 35 | δ 3.97 (s, 3H), 2.07 (m, 1H), 1.20–1.13 (m, 2H), 1.12–1.04 (m, 2H) |
| 38 | δ 6.20 (br s, 1H), 4.43 (q, 2H), 3.48 (m, 2H), 2.50 (m, 2H), 2.27 (s, 6H), 2.07 (m, 1H), 1.41 (t, 3H), 1.07 (m, 2H), 0.96 (m, 2H). |
| 39 | δ 5.90 (br s, 1H), 4.43 (q, 2H), 3.65 (m, 2H), 3.54 (m, 2H), 3.39 (s, 3H), 2.08 (m, 1H), 1.41 (t, 3H), 1.04 (m, 2H), 0.98 (m, 2H). |
| 40 | δ 8.59 (s, 1H), 4.44 (q, 2H), 3.20 (s, 3H), 3.18 (s, 3H), 2.10 (m, 1H), 1.41 (t, 3H), 1.11–1.05 (m, 2H), 1.01-0.94 (m, 2H). |
| 41 | δ 8.27 (m, 2H), 7.39 (m, 2H), 5.39 (br s, 2H), 4.23 (q, 2H), 3.93 (s, 2H), 1.29 (t, 3H). |
| 42 | δ 6.70 (br s, 1H), 4.43 (q, 2H), 4.0 (br s, 2H), 2.10 (m, 1H), 1.41 (t, 3H), 1.11 (m, 2H), 1.01 (m, 2H). |
| 43 | δ 8.35 (m, 2H), 7.10 (dd, 2H), 5.54 (br s, 2H), 4.02 (s, 3H). |
| 44 | δ 8.47 (d, 2H), 7.69 (d, 2H), 5.61 (br s, 2H), 4.04 (s, 3H). |

[a] $^1$H NMR data are in ppm downfield from tetramethylsilane. Couplings are designated by (s)-singlet, (d)-doublet, (t)-triplet, (q)-quartet, (m)-multiplet, (dd)-doublet of doublets, (dt)-doublet of triplets, (dq)-doublet of quartets, (br s)-broad singlet, (br d)-broad d, (br m)-broad multiplet.

## BIOLOGICAL EXAMPLES OF THE INVENTION

### TEST A

Seeds of barnyardgrass (*Echinochloa crus-galli*), crabgrass (*Digitaria sanguinalis*), giant foxtail (*Setaria faberi*), morningglory (*Ipomoea* spp.), redroot pigweed (*Amaranthus retroflexus*) and velvetleaf (*Abutilon theophrasti*) were planted into a blend of loam soil and sand and treated preemergence with a directed soil spray using test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant. At the same time these species were also treated with postemergence applications of test chemicals formulated in the same manner.

Plants ranged in height from 2 to 10 cm and were in the 1- to 2-leaf stage for the postemergence treatment. Treated plants and untreated controls were maintained in a greenhouse for approximately ten days, after which time all treated plants were compared to untreated controls and visually evaluated for injury. Plant response ratings, summarized in Table A, are based on a 0 to 100 scale where 0 is no effect and 100 is complete control. A dash (–) response means no test results.

| Table A | Compounds | |
|---|---|---|
| 2000 g ai/ha | 1 | 29 |
| Postemergence | | |
| Barnyardgrass | 75 | 30 |
| Crabgrass | 80 | 0 |
| Foxtail, Giant | 75 | 50 |
| Morningglory | 100 | 35 |
| Pigweed | 100 | 30 |
| Velvetleaf | 85 | 20 |

| Table A | Compounds | | |
|---|---|---|---|
| 500 g ai/ha | 1 | 20 | 29 |
| Postemergence | | | |
| Barnyardgrass | 75 | 0 | 0 |
| Crabgrass | 65 | 0 | 0 |
| Foxtail, Giant | 70 | 0 | 20 |
| Morningglory | 95 | 40 | 20 |
| Pigweed | 100 | 60 | 0 |
| Velvetleaf | 95 | 55 | 20 |

| Table A | Compound |
|---|---|
| 125 g ai/ha | 20 |
| Postemergence | |
| Barnyardgrass | 0 |
| Crabgrass | 0 |
| Foxtail, Giant | 0 |
| Morningglory | 20 |
| Pigweed | 40 |
| Velvetleaf | 10 |

| Table A | Compound |
|---|---|
| 1000 g ai/ha | 43 |
| Preemergence | |
| Barnyardgrass | 10 |
| Crabgrass | 10 |
| Foxtail, Giant | 10 |
| Morningglory | 45 |
| Pigweed | 75 |
| Velvetleaf | 20 |

| Table A | Compound |
|---|---|
| 1000 g ai/ha | 43 |
| Postemergence | |
| Barnyardgrass | 20 |
| Crabgrass | 30 |
| Foxtail, Giant | 10 |
| Morningglory | 45 |
| Pigweed | 85 |
| Velvetleaf | 50 |

| Table A | Compound |
|---|---|
| 250 g ai/ha | 43 |
| Postemergence | |
| Barnyardgrass | 10 |
| Crabgrass | 10 |
| Foxtail, Giant | 10 |
| Morningglory | 20 |
| Pigweed | 60 |
| Velvetleaf | 50 |

| Table A | Compounds | |
|---|---|---|
| 2000 g ai/ha | 1 | 29 |
| Preemergence | | |
| Barnyardgrass | 80 | 0 |
| Crabgrass | 75 | 25 |
| Foxtail, Giant | 85 | 30 |
| Morningglory | 100 | 0 |
| Pigweed | 100 | 85 |
| Velvetleaf | 80 | 0 |

| Table A | Compounds | | |
|---|---|---|---|
| 500 g ai/ha | 1 | 20 | 29 |
| Preemergence | | | |
| Barnyardgrass | 60 | 0 | 0 |
| Crabgrass | 25 | 0 | 0 |
| Foxtail, Giant | 40 | 0 | 0 |
| Morningglory | 85 | 60 | 0 |
| Pigweed | 85 | 70 | 15 |
| Velvetleaf | 60 | 70 | 0 |

| Table A | Compound |
|---|---|
| 250 g ai/ha | 43 |
| Preemergence | |
| Barnyardgrass | 0 |
| Crabgrass | 0 |
| Foxtail, Giant | 0 |
| Morningglory | 0 |
| Pigweed | 0 |
| Velvetleaf | 0 |

| Table A | Compound |
|---|---|
| 125 g ai/ha | 20 |
| Preemergence | |
| Barnyardgrass | 0 |
| Crabgrass | 0 |
| Foxtail, Giant | 0 |
| Morningglory | 10 |
| Pigweed | 40 |
| Velvetleaf | 0 |

TEST B

Seeds selected from barnyardgrass (*Echinochloa crus-galli*), Surinam grass (*Brachiaria decumbens*), cocklebur (*Xanthium strumarium*), corn (*Zea mays*), crabgrass (*Digitaria sanguinalis*), giant foxtail (*Setaria faberii*), lambsquarters (*Chenopodium album*), morningglory (*Ipomoea hederacea*), pigweed (*Amaranthus retroflexus*), rice (*Oryza sativa*), velvetleaf (*Abutilon theophrasti*), and wheat (*Triticum aestivum*) were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these crop and weed species and also blackgrass (*Alopecurus myosuroides*) and wild oat (*Avena fatua*) were treated with postemergence applications of test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Plant species in the flooded paddy test consisted of rice (*Oryza sativa*), umbrella sedge (*Cyperus difformis*), duck salad (*Heteranthera limosa*) and barnyardgrass (*Echinochloa crus-galli*) grown to the 2-leaf stage for testing. Treated plants and controls were maintained in a greenhouse for 13 to 15 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table B, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1000 g ai/ha | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Flood | | | | | | | | | | | | | | |
| Barnyardgrass | 80 | 90 | 0 | 90 | 50 | 0 | 20 | 70 | 90 | 0 | 0 | 0 | 0 | 80 |
| Ducksalad | 80 | 90 | 0 | 100 | 90 | 70 | 0 | 90 | 100 | 0 | 70 | 20 | 0 | 80 |
| Rice | 70 | 60 | 0 | 80 | 0 | 0 | 0 | 60 | 80 | 0 | 0 | 20 | 0 | 20 |
| Sedge, Umbrella | 20 | 90 | 0 | 80 | 90 | 50 | 0 | 40 | 90 | 0 | 20 | 0 | 0 | 50 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1000 g ai/ha | 15 | 16 | 17 | 18 | 19 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| Flood | | | | | | | | | | | | | | |
| Barnyardgrass | 90 | 90 | 80 | 0 | 80 | 60 | 80 | 0 | 0 | 30 | 60 | 0 | 0 | 0 |
| Ducksalad | 80 | 90 | 90 | 80 | 80 | 80 | 90 | 30 | 0 | 40 | 90 | 60 | 30 | 0 |
| Rice | 70 | 70 | 50 | 0 | 60 | 40 | 60 | 0 | 10 | 30 | 70 | 20 | 0 | 0 |
| Sedge, Umbrella | 70 | 60 | 50 | 0 | 70 | 0 | 50 | 0 | 20 | 40 | 80 | 60 | 0 | 0 |

| Table B | Compounds | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1000 g ai/ha | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| Flood | | | | | | | | | | |
| Barnyardgrass | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 0 |
| Ducksalad | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 |
| Rice | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sedge, Umbrella | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 0 | 0 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 g ai/ha | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Postemergence | | | | | | | | | | | | | | |
| Barnyardgrass | 90 | 10 | 90 | 0 | 30 | 90 | 90 | 10 | 90 | 40 | 10 | 90 | 90 | 90 |
| Blackgrass | 80 | 50 | 80 | 30 | 80 | 0 | 80 | 0 | 60 | 0 | 20 | 60 | 80 | 70 |
| Cocklebur | 100 | 100 | 100 | 90 | 100 | 100 | 100 | 70 | 90 | 70 | 40 | 70 | 100 | 100 |
| Corn | 80 | 0 | 90 | 0 | 30 | 90 | 90 | 0 | 0 | 0 | 0 | 70 | 80 | 80 |
| Crabgrass | 90 | 40 | 90 | 0 | 30 | 90 | 90 | 40 | 70 | 30 | 30 | 30 | 60 | 80 |
| Foxtail, Giant | 80 | 40 | 50 | 0 | 40 | 90 | 90 | 10 | 50 | 30 | 20 | 50 | 70 | 80 |
| Lambsquarters | 100 | 100 | 100 | 70 | 100 | 100 | 100 | 90 | 100 | 80 | 70 | 100 | 100 | 100 |
| Morningglory | 100 | 100 | 100 | 90 | 90 | 100 | 100 | 80 | 100 | 80 | 70 | 100 | 100 | 100 |
| Oat, Wild | 70 | 30 | 60 | 10 | 70 | 0 | 70 | 10 | 10 | 0 | 0 | 70 | 70 | 60 |
| Pigweed | 100 | 90 | 100 | 90 | 90 | 100 | 100 | 90 | 90 | 80 | 70 | 90 | 100 | 100 |
| Surinam Grass | 90 | 30 | 80 | 0 | 20 | 90 | 90 | 10 | 50 | 0 | 0 | 50 | 90 | 90 |
| Velvetleaf | 100 | 80 | 90 | 90 | 90 | 100 | 100 | 80 | 80 | 60 | 50 | 70 | 90 | 90 |
| Wheat | 70 | 20 | 60 | 20 | 80 | 0 | 70 | 0 | 40 | 0 | 0 | 50 | 70 | 60 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 g ai/ha | 17 | 18 | 19 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| Postemergence | | | | | | | | | | | | | | |
| Barnyardgrass | 90 | 0 | 90 | 0 | 90 | 0 | 10 | 80 | 60 | 0 | 50 | 10 | 80 | 0 |
| Blackgrass | 70 | 0 | 80 | 20 | 80 | 10 | 10 | 60 | 70 | 30 | 30 | 0 | 70 | 0 |
| Cocklebur | 100 | 70 | 100 | 10 | 100 | 90 | 70 | 90 | 90 | 100 | 100 | 0 | 100 | 80 |
| Corn | 80 | 0 | 70 | 0 | 80 | 0 | 10 | 30 | 20 | 20 | 0 | 0 | 30 | 0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crabgrass | 50 | 0 | 80 | 0 | 90 | 0 | 40 | 80 | 70 | 10 | 50 | 0 | 90 | 30 |
| Foxtail, Giant | 70 | 0 | 80 | 0 | 80 | 10 | 30 | 80 | 40 | 30 | 40 | 0 | 90 | 0 |
| Lambsquarters | 100 | 90 | 100 | 20 | 100 | 80 | 80 | 90 | 80 | 90 | 90 | 70 | 100 | 70 |
| Morningglory | 100 | 70 | 100 | 30 | 100 | 70 | 90 | 90 | 80 | 90 | 90 | 70 | 100 | 70 |
| Oat, Wild | 50 | 0 | 70 | 0 | 60 | 10 | 0 | 20 | 40 | 30 | 10 | 0 | 70 | 0 |
| Pigweed | 90 | 70 | 100 | 30 | 100 | 70 | 80 | 100 | 80 | 70 | 90 | 30 | 100 | 50 |
| Surinam Grass | 80 | 0 | 90 | 0 | 90 | 10 | 10 | 70 | 60 | 0 | 50 | 0 | 80 | 0 |
| Velvetleaf | 100 | 50 | 100 | 30 | 100 | 70 | 50 | 70 | 70 | 70 | 90 | 50 | 90 | 60 |
| Wheat | 60 | 0 | 60 | 20 | 70 | 20 | 0 | 30 | 30 | 30 | 10 | 0 | 60 | 0 |

| Table B | | | | | | Compounds | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 g ai/ha | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 44 |
| Postemergence | | | | | | | | | | | | |
| Barnyardgrass | 70 | 20 | 60 | 90 | 0 | 90 | 0 | 70 | 90 | 70 | 30 | 50 |
| Blackgrass | 40 | 40 | 70 | 70 | 40 | 60 | 0 | 0 | 60 | 60 | 60 | 40 |
| Cocklebur | 90 | 80 | 80 | 100 | 70 | 100 | 0 | 50 | 90 | - | 90 | 100 |
| Corn | 10 | 0 | 0 | 60 | 0 | 70 | 0 | 50 | 60 | 80 | 0 | 70 |
| Crabgrass | 20 | 20 | 30 | 50 | 0 | 80 | 20 | 40 | 80 | 20 | 30 | 80 |
| Foxtail, Giant | 20 | 40 | 50 | 60 | 10 | 60 | 0 | 30 | 60 | 30 | 0 | - |
| Lambsquarters | 80 | 70 | 90 | 100 | 50 | 100 | 60 | 90 | 100 | 90 | 90 | 90 |
| Morningglory | 90 | 70 | 70 | 100 | 70 | 100 | 40 | 100 | 100 | 90 | 90 | 100 |
| Oat, Wild | 30 | 20 | 40 | 60 | 40 | 0 | 0 | 0 | 60 | 0 | 0 | 0 |
| Pigweed | 80 | 80 | 80 | 100 | 30 | 100 | 30 | 70 | 100 | 90 | 90 | 90 |
| Surinam Grass | 10 | 0 | 50 | 80 | 0 | 70 | 20 | 30 | 70 | 10 | 10 | 50 |
| Velvetleaf | 50 | 50 | 60 | 90 | 40 | 100 | 50 | 70 | 90 | 70 | 80 | 90 |
| Wheat | 30 | 20 | 40 | 60 | 40 | 60 | 0 | 0 | 60 | 40 | 50 | 30 |

| Table B | Compounds | |
|---|---|---|
| 250 g ai/ha | 1 | 4 |
| Postemergence | | |
| Barnyardgrass | 90 | 90 |
| Blackgrass | 70 | 90 |
| Cocklebur | 90 | 100 |
| Corn | 70 | 90 |
| Crabgrass | 90 | 90 |
| Foxtail, Giant | 80 | 90 |
| Lambsquarters | 100 | 100 |
| Morningglory | 100 | 100 |
| Oat, Wild | 60 | 80 |

| | | |
|---|---|---|
| Pigweed | 100 | 100 |
| Surinam Grass | 90 | 90 |
| Velvetleaf | 90 | 100 |
| Wheat | 70 | 80 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 g ai/ha | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Postemergence | | | | | | | | | | | | | | |
| Barnyardgrass | 90 | 0 | 50 | 0 | 0 | 90 | 90 | 0 | 20 | 0 | 0 | 30 | 90 | 70 |
| Blackgrass | 50 | 20 | 70 | 10 | 60 | 0 | 60 | 0 | 20 | 0 | 10 | 30 | 70 | 10 |
| Cocklebur | 100 | 70 | 80 | 40 | 90 | 100 | 100 | 60 | 80 | 40 | 10 | 50 | 100 | 90 |
| Corn | 20 | 0 | 30 | 0 | 0 | 70 | 70 | 0 | 0 | 0 | 0 | 30 | 50 | 30 |
| Crabgrass | 90 | 30 | 50 | 0 | 10 | 80 | 90 | 30 | 30 | 10 | 20 | 10 | 30 | 30 |
| Foxtail, Giant | 70 | 20 | 40 | 0 | 20 | 80 | 90 | 0 | 10 | 0 | 10 | 20 | 40 | 30 |
| Lambsquarters | 100 | 100 | 100 | 30 | 80 | 100 | 90 | 80 | 90 | 60 | 60 | 100 | 100 | 100 |
| Morningglory | 100 | 80 | 100 | 0 | 80 | 100 | 100 | 80 | 80 | 60 | 50 | 100 | 100 | 100 |
| Oat, Wild | 40 | 10 | 40 | 0 | 40 | 0 | 20 | 0 | 0 | 0 | 0 | 20 | 10 | 10 |
| Pigweed | 100 | 80 | 90 | 20 | 0 | 100 | 100 | 80 | 80 | 50 | 50 | 80 | 80 | 90 |
| Surinam Grass | 90 | 10 | 50 | 0 | 0 | 80 | 90 | 10 | 20 | 0 | 0 | 10 | 60 | 60 |
| Velvetleaf | 60 | 50 | 70 | 20 | 50 | 80 | 100 | 50 | 60 | 20 | 40 | 50 | 80 | 80 |
| Wheat | 40 | 10 | 50 | 10 | 50 | 0 | 40 | 0 | 0 | 0 | 0 | 20 | 40 | 30 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 g ai/ha | 17 | 18 | 19 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 32 |
| Postemergence | | | | | | | | | | | | | | |
| Barnyardgrass | 20 | 0 | 80 | 0 | 70 | 0 | 0 | 40 | 20 | 0 | 20 | 0 | 0 | 20 |
| Blackgrass | 0 | 0 | 60 | 10 | 60 | 0 | 0 | 10 | 40 | 30 | 10 | 0 | 60 | 30 |
| Cocklebur | 100 | 70 | 90 | 0 | 100 | 30 | 50 | 90 | 80 | 100 | 90 | 0 | 100 | 40 |
| Corn | 0 | 0 | 30 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crabgrass | 20 | 0 | 40 | 0 | 50 | 0 | 20 | 60 | 40 | 10 | 30 | 0 | 30 | 10 |
| Foxtail, Giant | 10 | 0 | 20 | 0 | 70 | 0 | 20 | 50 | 30 | 20 | 20 | 0 | 0 | 10 |
| Lambsquarters | 100 | 70 | 100 | 10 | 100 | 70 | 70 | 90 | 70 | 80 | 90 | 30 | 90 | 70 |
| Morningglory | 100 | 20 | 100 | 10 | 90 | 40 | 60 | 90 | 70 | 70 | 90 | 20 | 90 | 40 |
| Oat, Wild | 0 | 0 | 40 | 0 | 10 | 10 | 0 | 10 | 30 | 20 | 0 | 0 | 60 | 20 |
| Pigweed | 70 | 20 | 90 | 0 | 100 | 30 | 70 | 90 | 70 | 60 | 80 | 0 | 90 | 80 |
| Surinam Grass | 30 | 0 | 40 | 0 | 80 | 0 | 0 | 50 | 30 | 0 | 10 | 0 | 10 | 0 |
| Velvetleaf | 60 | 20 | 70 | 10 | 100 | 40 | 40 | 60 | 40 | 60 | 70 | 10 | 50 | 10 |
| Wheat | 0 | 0 | 20 | 10 | 0 | 0 | 0 | 20 | 30 | 20 | 0 | 0 | 50 | 20 |

| Table B | Compounds | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 g ai/ha | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 44 |
| Postemergence | | | | | | | | | | | |
| Barnyardgrass | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 20 | 10 | 40 |
| Blackgrass | 40 | 60 | 60 | 0 | 40 | 0 | 0 | 50 | 20 | 30 | 30 |
| Cocklebur | 60 | 80 | 30 | 20 | 100 | 0 | 30 | 0 | 70 | 80 | 90 |
| Corn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 30 |
| Crabgrass | 10 | 0 | 20 | 0 | 60 | 0 | 0 | 0 | 10 | 0 | 70 |
| Foxtail, Giant | 10 | 20 | 10 | 0 | 10 | 0 | 0 | 0 | 20 | 0 | - |
| Lambsquarters | 60 | 70 | 90 | 40 | 100 | 20 | 70 | 0 | 80 | 80 | 90 |
| Morningglory | 40 | 60 | 70 | 10 | 90 | 10 | 80 | 0 | 70 | 80 | 80 |
| Oat, Wild | 20 | 30 | 60 | 0 | 0 | 0 | 0 | 40 | 0 | 0 | 0 |
| Pigweed | 60 | 50 | 70 | 20 | 100 | 30 | 50 | 0 | 70 | 80 | 80 |
| Surinam Grass | 0 | 10 | 20 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | - |
| Velvetleaf | 40 | 30 | 50 | 20 | 80 | 0 | 40 | 0 | 50 | 50 | 80 |
| Wheat | 20 | 30 | 20 | 0 | 0 | 0 | 0 | 50 | 30 | 50 | 0 |

| Table B | Compounds | | |
|---|---|---|---|
| 62 g ai/ha | 1 | 4 | 31 |
| Postemergence | | | |
| Barnyardgrass | 50 | 70 | 0 |
| Blackgrass | 40 | 70 | 0 |
| Cocklebur | 90 | 90 | 70 |
| Corn | 30 | 50 | 0 |
| Crabgrass | 70 | 80 | 0 |
| Foxtail, Giant | 50 | 80 | 0 |
| Lambsquarters | 100 | 100 | 40 |
| Morningglory | 90 | 90 | 50 |
| Oat, Wild | 20 | 50 | 0 |
| Pigweed | 90 | 100 | 20 |
| Surinam Grass | 60 | 90 | 0 |
| Velvetleaf | 90 | 70 | 10 |
| Wheat | 30 | 40 | 0 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 g ai/ha | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Preemergence | | | | | | | | | | | | | | |
| Barnyardgrass | 90 | 0 | 30 | 0 | 30 | 90 | 90 | 50 | 10 | 80 | 80 | 80 | 90 | 90 |
| Cocklebur | 100 | 80 | 80 | 60 | 80 | 100 | 100 | 90 | 90 | 90 | 100 | 80 | 100 | 100 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Corn | 80 | 0 | 70 | 0 | 0 | 90 | 80 | 0 | 0 | 30 | 30 | 70 | 80 | 70 |
| Crabgrass | 90 | 50 | 70 | 0 | 30 | 90 | 100 | 60 | 80 | 70 | 70 | 80 | 90 | 100 |
| Foxtail, Giant | 90 | 0 | 10 | 0 | 0 | 90 | 80 | 20 | 70 | 50 | 40 | 80 | 80 | 80 |
| Lambsquarters | 100 | 90 | 100 | 0 | 90 | 100 | 100 | 90 | 100 | 100 | 100 | 100 | 100 | 100 |
| Morningglory | 100 | 60 | 80 | 0 | 80 | 100 | 100 | 90 | 90 | 90 | 100 | 100 | 100 | 100 |
| Pigweed | 100 | 90 | 90 | 0 | 90 | 100 | 100 | 90 | 90 | 90 | 90 | 90 | 100 | 90 |
| Surinam Grass | 90 | 20 | 10 | 10 | 0 | 90 | 90 | 0 | 70 | - | - | 80 | 90 | 80 |
| Velvetleaf | 100 | 70 | 90 | 30 | 80 | 100 | 100 | 90 | 90 | 90 | 90 | 80 | 100 | 100 |
| Wheat | 70 | 0 | 50 | 0 | 30 | 80 | 80 | 0 | 50 | 60 | 60 | 50 | 60 | 60 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 g ai/ha | 17 | 18 | 19 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| Preemergence | | | | | | | | | | | | | | |
| Barnyardgrass | 80 | 0 | 90 | 10 | 20 | 0 | 20 | 60 | 90 | 60 | 30 | 0 | 40 | 70 |
| Cocklebur | 90 | 40 | 100 | 80 | 80 | 10 | 90 | 90 | 90 | 90 | 90 | 0 | 100 | 100 |
| Corn | 60 | 0 | 90 | - | - | 0 | 0 | 0 | 80 | 50 | 0 | 0 | 80 | 40 |
| Crabgrass | 100 | 0 | 90 | 60 | 100 | 0 | 80 | 70 | 90 | 70 | 80 | 0 | 90 | 80 |
| Foxtail, Giant | 70 | 0 | 80 | 10 | 20 | 0 | 60 | 80 | 80 | 40 | 50 | 0 | 80 | 80 |
| Lambsquarters | 100 | 60 | 100 | 80 | 100 | 30 | 90 | 90 | 100 | 100 | 100 | 0 | 90 | 100 |
| Morningglory | 100 | 0 | 100 | 90 | 100 | 10 | 90 | 90 | 100 | 90 | 90 | 0 | 100 | 100 |
| Pigweed | 100 | 70 | 100 | 70 | 80 | 20 | 90 | 90 | 100 | 100 | 90 | 0 | 90 | 100 |
| Surinam Grass | 90 | 0 | 90 | 20 | 20 | 0 | 50 | 70 | 80 | 70 | 60 | 0 | 80 | 60 |
| Velvetleaf | 90 | 40 | 100 | 80 | 100 | 20 | 80 | 80 | 100 | 90 | 90 | 0 | 80 | 90 |
| Wheat | 60 | 0 | 60 | 30 | 50 | 0 | 70 | 60 | 60 | 50 | 40 | 0 | 60 | 70 |

| Table B | Compounds | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 g ai/ha | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 44 |
| Preemergence | | | | | | | | | | | | |
| Barnyardgrass | 10 | 50 | 0 | 80 | 0 | 40 | 0 | 20 | 90 | 10 | 0 | 10 |
| Cocklebur | 90 | 90 | 60 | 90 | 60 | 80 | 0 | 30 | 100 | 10 | 70 | 80 |
| Corn | 0 | 30 | 0 | 50 | 0 | 10 | 10 | 50 | 50 | 0 | 0 | 0 |
| Crabgrass | 40 | 50 | 70 | 80 | 0 | 90 | 0 | 50 | 80 | 20 | 20 | 80 |
| Foxtail, Giant | 0 | 40 | 20 | 70 | 0 | 60 | 0 | 20 | 80 | 0 | 0 | 40 |
| Lambsquarters | 90 | 100 | 80 | 100 | 40 | 100 | 90 | 100 | 100 | 60 | 90 | 60 |
| Morningglory | 80 | 90 | 70 | 100 | 0 | 50 | 50 | 70 | 100 | 20 | 80 | 40 |
| Pigweed | 90 | 90 | 80 | 100 | 20 | 100 | 70 | 100 | 100 | 60 | 90 | 80 |
| Surinam Grass | 0 | 40 | 50 | 60 | 0 | 40 | 0 | 0 | 70 | 0 | 20 | 60 |
| Velvetleaf | 80 | 80 | 60 | 90 | 40 | 80 | 0 | 30 | 90 | 30 | 70 | 80 |
| Wheat | 10 | 50 | 10 | 50 | 0 | 60 | 0 | 10 | 70 | 20 | 10 | 60 |

| Table B | Compounds | |
|---|---|---|
| 250 g ai/ha | 1 | 4 |
| Preemergence | | |
| Barnyardgrass | 90 | 90 |
| Cocklebur | 100 | 100 |
| Corn | 80 | 80 |
| Crabgrass | 90 | 90 |
| Foxtail, Giant | 90 | 80 |
| Lambsquarters | 100 | 100 |
| Morningglory | 100 | 100 |
| Pigweed | 100 | 100 |
| Surinam Grass | 80 | 90 |
| Velvetleaf | 100 | 90 |
| Wheat | 60 | 70 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 g ai/ha | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Preemergence | | | | | | | | | | | | | | |
| Barnyardgrass | 70 | 0 | 10 | 0 | 0 | 70 | 50 | 20 | 0 | 50 | 40 | 10 | 40 | 30 |
| Cocklebur | 90 | 80 | 70 | 10 | 70 | 90 | 90 | 80 | 80 | 80 | 90 | 60 | 70 | 70 |
| Corn | 0 | 0 | 0 | 0 | 0 | 90 | 50 | 0 | 0 | 0 | - | 0 | 20 | 30 |
| Crabgrass | 90 | 10 | 20 | 0 | 0 | 80 | 90 | 20 | 30 | 20 | 50 | 10 | 70 | 70 |
| Foxtail, Giant | 30 | 0 | 0 | 0 | 0 | 50 | 70 | 0 | 10 | 20 | 20 | 30 | 40 | 30 |
| Lambsquarters | 100 | 70 | 90 | 0 | 80 | 90 | 90 | - | 100 | 90 | 90 | 90 | 90 | 100 |
| Morningglory | 100 | 50 | 70 | 0 | 70 | 100 | 100 | 80 | 80 | 70 | 90 | 70 | 70 | 90 |
| Pigweed | 90 | 80 | 90 | 0 | 90 | 100 | 90 | 80 | 80 | 80 | 80 | 80 | 90 | 90 |
| Surinam Grass | 40 | 0 | 0 | 10 | 0 | 60 | 70 | 0 | 10 | 0 | 0 | 40 | 30 | 40 |
| Velvetleaf | 90 | 40 | 70 | 0 | 50 | 80 | 90 | 80 | 80 | 80 | 80 | 60 | 70 | 80 |
| Wheat | 60 | 0 | - | 0 | 0 | 60 | 40 | 0 | 0 | 30 | 40 | 40 | 40 | 50 |

| Table B | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 g ai/ha | 17 | 18 | 19 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 32 |
| Preemergence | | | | | | | | | | | | | | |
| Barnyardgrass | 20 | 0 | 40 | 0 | 0 | 0 | 0 | 20 | 50 | 30 | 10 | 0 | 10 | 0 |
| Cocklebur | 80 | 10 | 90 | 30 | 50 | 0 | 80 | 80 | 80 | 80 | 80 | 0 | 60 | 80 |
| Corn | 0 | 0 | 70 | 0 | 10 | 0 | - | 0 | 30 | 10 | 0 | 0 | 10 | 0 |
| Crabgrass | 70 | 0 | 80 | 0 | 20 | 0 | 60 | 60 | 30 | 30 | 70 | 0 | 50 | 0 |
| Foxtail, Giant | 20 | 0 | 20 | 0 | 0 | 0 | 10 | 40 | 10 | 0 | 30 | 0 | 10 | 0 |
| Lambsquarters | 90 | 10 | 100 | 70 | 70 | 0 | 70 | 90 | 100 | 90 | 80 | 0 | 80 | 40 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Morningglory | 100 | 0 | 90 | 50 | 100 | 0 | 50 | 80 | 90 | 80 | 80 | 0 | 90 | 40 |
| Pigweed | 80 | 0 | 90 | 50 | 60 | 0 | 80 | 80 | 90 | 90 | 80 | 0 | 50 | 40 |
| Surinam Grass | 30 | 0 | 60 | 0 | 0 | 0 | 10 | 20 | 10 | 0 | - | 0 | 0 | 0 |
| Velvetleaf | 70 | 0 | 90 | 10 | 30 | 0 | 50 | 70 | 90 | 80 | 80 | 0 | 10 | 50 |
| Wheat | 40 | 0 | 50 | 0 | 10 | 0 | 30 | 50 | 30 | 10 | 10 | 0 | 30 | 0 |

| Table B | | | | | Compounds | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 g ai/ha | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 44 |
| Preemergence | | | | | | | | | | | |
| Barnyardgrass | 20 | 0 | 10 | 0 | 10 | 0 | 0 | 50 | 0 | 0 | 0 |
| Cocklebur | 80 | 30 | 60 | 10 | 20 | 0 | 10 | 90 | 0 | 40 | 10 |
| Corn | 10 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 |
| Crabgrass | 0 | 0 | 30 | 0 | 50 | 0 | 0 | 60 | 0 | 0 | 40 |
| Foxtail, Giant | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 20 | 0 | 0 | 20 |
| Lambsquarters | 90 | 50 | 90 | 0 | 100 | 20 | 50 | 100 | 30 | 40 | - |
| Morningglory | 0 | 20 | 70 | 0 | 10 | 0 | 30 | 90 | 0 | 20 | 10 |
| Pigweed | 80 | 40 | 80 | 0 | 100 | 10 | 70 | 90 | 0 | 50 | 70 |
| Surinam Grass | 0 | 10 | 10 | 0 | - | 0 | 0 | 50 | - | 0 | 40 |
| Velvetleaf | 70 | 30 | 70 | 10 | 40 | 0 | 0 | 90 | 10 | 10 | 30 |
| Wheat | 0 | 0 | 20 | 0 | 30 | 0 | 0 | 40 | 0 | 10 | 30 |

| Table B | Compounds | | |
|---|---|---|---|
| 62 g ai/ha | 1 | 4 | 31 |
| Preemergence | | | |
| Barnyardgrass | 60 | 30 | 20 |
| Cocklebur | 90 | 80 | 90 |
| Corn | 20 | 0 | 0 |
| Crabgrass | 90 | 70 | 10 |
| Foxtail, Giant | 30 | 10 | 10 |
| Lambsquarters | 100 | 90 | 90 |
| Morningglory | 90 | 60 | 90 |
| Pigweed | 90 | 90 | 90 |
| Surinam Grass | 50 | 40 | 20 |
| Velvetleaf | 90 | 80 | 80 |
| Wheat | 30 | 50 | 40 |

<u>TEST C</u>

Seeds of plant species selected from bermudagrass (*Cynodon dactylon*), Surinam grass (*Brachiaria decumbens*), cocklebur (*Xanthium strumarium*), corn (*Zea mays*), crabgrass (*Digitaria sanguinalis*), woolly cupgrass (*Eriochloa villosa*), giant foxtail (*Setaria faberii*),

goosegrass (*Eleusine indica*), johnsongrass (*Sorghum halepense*), kochia (*Kochia scoparia*), lambsquarters (*Chenopodium album*), morningglory (*Ipomoea hederacea*), eastern black nightshade (*Solanum ptycanthum*), yellow nutsedge (*Cyperus esculentus*), pigweed (*Amaranthus retroflexus*), common ragweed (*Ambrosia elatior*), soybean (*Glycine max*), common (oilseed) sunflower (*Helianthus annuus*), and velvetleaf (*Abutilon theophrasti*) were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these crop and weed species and also winter barley (*Hordeum vulgare*), blackgrass (*Alopecurus myosuroides*), canarygrass (*Phalaris minor*), chickweed (*Stellaria media*), downy brome (*Bromus tectorum*), green foxtail (*Setaria viridis*), Italian ryegrass (*Lolium multiflorum*), wheat (*Triticum aestivum*), wild oat (*Avena fatua*) and windgrass (*Apera spica-venti*) were treated with postemergence applications of some of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Plant species in the flooded paddy test consisted of rice (*Oryza sativa*), umbrella sedge (*Cyperus difformis*), duck salad (*Heteranthera limosa*) and barnyardgrass (*Echinochloa crus-galli*) grown to the 2-leaf stage for testing. Treated plants and controls were maintained in a greenhouse for 12 to 14 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table C, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

| Table C | | | | | Compounds | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 500 g ai/ha | 1 | 2 | 4 | 5 | 9 | 14 | 15 | 16 | 17 | 19 | 22 |
| Flood | | | | | | | | | | | |
| Barnyardgrass | 25 | 75 | 85 | 20 | 85 | 45 | 75 | 50 | 50 | 60 | 70 |
| Ducksalad | 0 | 95 | 100 | 0 | 90 | 55 | 85 | 85 | 80 | 60 | 95 |
| Rice | 0 | 65 | 80 | 0 | 75 | 0 | 50 | 65 | 75 | 20 | 60 |
| Sedge, Umbrella | 0 | 25 | 75 | 0 | 85 | 30 | 25 | 55 | 25 | 50 | 95 |

| Table C | | | | | Compounds | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 250 g ai/ha | 1 | 2 | 4 | 5 | 9 | 14 | 15 | 16 | 17 | 19 | 22 |
| Flood | | | | | | | | | | | |
| Barnyardgrass | 15 | 45 | 65 | 0 | 55 | 0 | 25 | 15 | 0 | 0 | 40 |
| Ducksalad | 0 | 90 | 90 | 0 | 80 | 45 | 50 | 75 | 80 | 60 | 90 |
| Rice | 0 | 45 | 75 | 0 | 55 | 0 | 20 | 0 | 45 | 10 | 40 |
| Sedge, Umbrella | 0 | 0 | 65 | 0 | 15 | 0 | 10 | 50 | 20 | 50 | 75 |

| Table C | Compounds | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 g ai/ha | 1 | 2 | 4 | 5 | 9 | 14 | 15 | 16 | 17 | 19 | 22 |
| Flood | | | | | | | | | | | |
| Barnyardgrass | 0 | 20 | 60 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ducksalad | - | 70 | 80 | 0 | 70 | 40 | 45 | 65 | 0 | 40 | 60 |
| Rice | 0 | 25 | 40 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | 20 |
| Sedge, Umbrella | - | 0 | 30 | 0 | 15 | 0 | 0 | 0 | 0 | 50 | 30 |

| Table C | Compounds | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 g ai/ha | 1 | 2 | 4 | 5 | 9 | 14 | 15 | 16 | 17 | 19 | 22 |
| Flood | | | | | | | | | | | |
| Barnyardgrass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ducksalad | 0 | 50 | 70 | 0 | 45 | 0 | 45 | 65 | 0 | 20 | 30 |
| Rice | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| Sedge, Umbrella | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 20 | 0 |

| Table C | Compounds | | | | | | |
|---|---|---|---|---|---|---|---|
| 500 g ai/ha | 1 | 4 | 5 | 7 | 8 | 10 | 15 |
| Postemergence | | | | | | | |
| Barley | - | 65 | - | - | - | - | - |
| Bermudagrass | 90 | 80 | 80 | 0 | 75 | 0 | 75 |
| Blackgrass | - | 70 | - | - | - | - | - |
| Brome, Downy | - | 70 | - | - | - | - | - |
| Canarygrass | - | 60 | - | - | - | - | - |
| Chickweed | - | 100 | - | 0 | 100 | 70 | 85 |
| Cocklebur | 100 | 100 | 100 | 30 | 100 | 75 | 100 |
| Corn | 45 | 95 | 45 | 0 | 90 | 0 | 75 |
| Crabgrass | 90 | 80 | 80 | 25 | 75 | 0 | 80 |
| Cupgrass, Woolly | 90 | 95 | 70 | 20 | 85 | 0 | 75 |
| Foxtail, Giant | 90 | 95 | 60 | 10 | 75 | 0 | 70 |
| Foxtail, Green | - | 75 | - | - | - | - | - |
| Goosegrass | 70 | 75 | 50 | 0 | 60 | 0 | 55 |
| Johnsongrass | 70 | 95 | 45 | 0 | 85 | 0 | 80 |
| Kochia | 100 | 100 | 100 | 80 | 100 | 100 | 100 |
| Lambsquarters | 100 | 100 | 100 | 80 | 100 | 100 | 100 |
| Morningglory | 100 | 100 | 100 | 65 | 100 | 95 | 100 |
| Nutsedge, Yellow | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oat, Wild | - | 70 | - | - | - | - | - |
| Pigweed | 100 | 100 | 100 | 55 | 100 | 95 | 100 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ragweed | 100 | 100 | 100 | 75 | 100 | 90 | 95 |
| Ryegrass, Italian | - | 65 | - | - | - | - | - |
| Soybean | 100 | 100 | 100 | 60 | 100 | 100 | 100 |
| Surinam Grass | 95 | 95 | 70 | 0 | 80 | 0 | 65 |
| Velvetleaf | 100 | 100 | 95 | 40 | 95 | 90 | 90 |
| Wheat | - | 65 | - | - | - | - | - |
| Windgrass | - | 75 | - | - | - | - | - |

| Table C | | | | | | Compounds | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 250 g ai/ha | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 15 | 16 | 17 |
| Postemergence | | | | | | | | | | | | |
| Barley | - | 60 | 30 | 65 | - | - | - | - | - | - | - | - |
| Bermudagrass | 90 | 80 | 45 | 70 | 70 | 0 | 65 | 80 | 0 | 65 | 75 | 0 |
| Blackgrass | - | 75 | 0 | 70 | - | - | - | - | - | - | - | - |
| Brome, Downy | - | 60 | 20 | 65 | - | - | - | - | - | - | - | - |
| Canarygrass | - | 40 | 10 | 60 | - | - | - | - | - | - | - | - |
| Chickweed | 90 | 95 | 40 | 100 | 20 | 0 | 95 | 100 | 20 | 65 | 35 | 85 |
| Cocklebur | 100 | 85 | 90 | 100 | 100 | 30 | 100 | 100 | 60 | 100 | 100 | 100 |
| Corn | 40 | 30 | 0 | 90 | 40 | 0 | 70 | 95 | 0 | 55 | 55 | 20 |
| Crabgrass | 85 | 70 | 0 | 75 | 70 | 5 | 70 | 80 | 0 | 65 | 75 | 65 |
| Cupgrass, Woolly | 90 | 75 | 0 | 85 | 50 | 0 | 75 | 85 | 0 | 65 | 65 | 20 |
| Foxtail, Giant | 80 | 70 | 0 | 85 | 50 | 0 | 70 | 80 | 0 | 65 | 65 | 35 |
| Foxtail, Green | - | 70 | 35 | 70 | - | - | - | - | - | - | - | - |
| Goosegrass | 40 | 45 | 0 | 65 | 40 | 0 | 45 | 45 | 0 | 40 | 20 | 0 |
| Johnsongrass | 70 | 60 | 0 | 95 | 45 | 0 | 45 | 85 | 0 | 70 | 70 | 60 |
| Kochia | 100 | 100 | 100 | 100 | 100 | 70 | 100 | 100 | 95 | 100 | 100 | 100 |
| Lambsquarters | 100 | 100 | 100 | 100 | 100 | 70 | 100 | 100 | 90 | 100 | 100 | 100 |
| Morningglory | 100 | 100 | 75 | 100 | 100 | 55 | 100 | 100 | 95 | 100 | 100 | 100 |
| Nutsedge, Yellow | 5 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oat, Wild | - | 60 | 40 | 70 | - | - | - | - | - | - | - | - |
| Pigweed | 100 | 100 | 80 | 100 | 90 | 40 | 100 | 100 | 95 | 85 | 95 | 95 |
| Ragweed | 100 | 95 | 95 | 100 | 95 | 65 | 95 | 100 | 80 | 90 | 95 | 95 |
| Ryegrass, Italian | - | 60 | 35 | 65 | - | - | - | - | - | - | - | - |
| Soybean | 100 | 100 | 95 | 100 | 100 | 35 | 100 | 100 | 90 | 95 | 100 | 100 |
| Surinam Grass | 90 | 70 | 0 | 75 | 30 | 0 | 70 | 80 | 0 | 55 | 55 | 0 |
| Velvetleaf | 100 | 100 | 70 | 100 | 90 | 35 | 85 | 95 | 80 | 85 | 90 | 95 |
| Wheat | - | 65 | 10 | 65 | - | - | - | - | - | - | - | - |
| Windgrass | - | 70 | 30 | 70 | - | - | - | - | - | - | - | - |

| Table C 125 g ai/ha Postemergence | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barley | - | 60 | 0 | 65 | - | - | - | - | - | - | - | - | - | - |
| Bermudagrass | 90 | 70 | 0 | 65 | 50 | 0 | 0 | 60 | 70 | 0 | 0 | 45 | 60 | 0 |
| Blackgrass | - | 70 | 0 | 65 | - | - | - | - | - | - | - | - | - | - |
| Brome, Downy | - | 45 | 20 | 60 | - | - | - | - | - | - | - | - | - | - |
| Canarygrass | - | 40 | 10 | 45 | - | - | - | - | - | - | - | - | - | - |
| Chickweed | - | 75 | 0 | 85 | 10 | 0 | 0 | 75 | 100 | 0 | 0 | 50 | 20 | 55 |
| Cocklebur | 100 | 85 | 75 | 100 | 95 | 5 | 30 | 100 | 100 | 15 | 40 | 100 | 100 | 100 |
| Corn | 15 | 20 | 0 | 80 | 40 | 0 | 0 | 20 | 65 | 0 | 0 | 15 | 20 | 0 |
| Crabgrass | 85 | 60 | 0 | 75 | 50 | 5 | 0 | 65 | 75 | 0 | 20 | 45 | 45 | 20 |
| Cupgrass, Woolly | 80 | 70 | 0 | 70 | 50 | 0 | 0 | 60 | 70 | 0 | 0 | 50 | 0 | 0 |
| Foxtail, Giant | 65 | 65 | 0 | 75 | 30 | 0 | 0 | 60 | 75 | 0 | 0 | 60 | 55 | 0 |
| Foxtail, Green | - | 65 | 35 | 70 | - | - | - | - | - | - | - | - | - | - |
| Goosegrass | 0 | 0 | 0 | 20 | 5 | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | 0 |
| Johnsongrass | 30 | 25 | 0 | 80 | 40 | 0 | 0 | 35 | 80 | 0 | 0 | 55 | 60 | 40 |
| Kochia | 100 | 95 | 90 | 100 | 100 | 40 | 65 | 100 | 100 | 90 | 90 | 95 | 100 | 100 |
| Lambsquarters | 100 | 100 | 90 | 100 | 100 | 30 | 60 | 100 | 100 | 80 | 80 | 100 | 100 | 100 |
| Morningglory | 100 | 100 | 65 | 100 | 95 | 0 | 50 | 95 | 100 | 85 | 0 | 95 | 100 | 100 |
| Nutsedge, Yellow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oat, Wild | - | 55 | 40 | 65 | - | - | - | - | - | - | - | - | - | - |
| Pigweed | 100 | 95 | 75 | 100 | 90 | 0 | 40 | 75 | 100 | 80 | 90 | 70 | 95 | 75 |
| Ragweed | 100 | 90 | 80 | 100 | 95 | 10 | 35 | 80 | 95 | 65 | 75 | 85 | 95 | 95 |
| Ryegrass, Italian | - | 60 | 35 | 60 | - | - | - | - | - | - | - | - | - | - |
| Soybean | 100 | 100 | 90 | 100 | 100 | 40 | 25 | 95 | 100 | 80 | 95 | 95 | 100 | 100 |
| Surinam Grass | 90 | 65 | 0 | 75 | 20 | 0 | 0 | 65 | 75 | 0 | 0 | 20 | 25 | 0 |
| Velvetleaf | 90 | 80 | 55 | 100 | 90 | 5 | 10 | 70 | 80 | 70 | 75 | 70 | 65 | 80 |
| Wheat | - | 65 | 0 | 60 | - | - | - | - | - | - | - | - | - | - |
| Windgrass | - | 70 | 30 | 65 | - | - | - | - | - | - | - | - | - | - |

(Compounds)

| Table C 125 g ai/ha Postemergence | Compound 19 |
|---|---|
| Barley | 45 |
| Bermudagrass | 45 |
| Blackgrass | 65 |
| Brome, Downy | 60 |
| Canarygrass | 65 |

| | |
|---|---|
| Chickweed | 5 |
| Cocklebur | 90 |
| Corn | 35 |
| Crabgrass | 70 |
| Cupgrass, Woolly | 65 |
| Foxtail, Giant | 55 |
| Foxtail, Green | 60 |
| Goosegrass | 0 |
| Johnsongrass | - |
| Kochia | 90 |
| Lambsquarters | 95 |
| Morningglory | 85 |
| Nutsedge, Yellow | 0 |
| Oat, Wild | 65 |
| Pigweed | 65 |
| Ragweed | 80 |
| Ryegrass, Italian | 70 |
| Soybean | 75 |
| Surinam Grass | - |
| Velvetleaf | 60 |
| Wheat | 45 |
| Windgrass | 60 |

| Table C | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 g ai/ha | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 15 | 16 | 17 |
| Postemergence | | | | | | | | | | | | | | |
| Barley | - | 35 | 0 | 30 | - | - | - | - | - | - | - | - | - | - |
| Bermudagrass | 70 | 60 | 0 | 40 | 5 | 0 | 0 | 50 | 65 | 0 | 0 | 0 | 0 | 0 |
| Blackgrass | - | 65 | 0 | 65 | - | - | - | - | - | - | - | - | - | - |
| Brome, Downy | - | 35 | 20 | 45 | - | - | - | - | - | - | - | - | - | - |
| Canarygrass | - | 40 | 10 | 35 | - | - | - | - | - | - | - | - | - | - |
| Chickweed | 80 | 65 | 0 | 30 | 0 | 0 | 0 | 20 | 85 | 0 | 0 | 20 | 0 | 0 |
| Cocklebur | 90 | 75 | 65 | 85 | 80 | 0 | 30 | 80 | 85 | 0 | 25 | 85 | 95 | 100 |
| Corn | 10 | 15 | 0 | 0 | 10 | 0 | 0 | 0 | 55 | 0 | 0 | 15 | 0 | 0 |
| Crabgrass | 30 | 55 | 0 | 70 | 40 | 0 | 0 | 60 | 70 | 0 | 0 | 15 | 15 | 0 |
| Cupgrass, Woolly | 65 | 60 | 0 | 60 | 5 | 0 | 0 | 30 | 60 | 0 | 0 | 0 | 0 | 0 |
| Foxtail, Giant | 40 | 35 | 0 | 60 | 20 | 0 | 0 | 40 | 65 | 0 | 0 | 45 | 20 | 0 |
| Foxtail, Green | - | 55 | 30 | 65 | - | - | - | - | - | - | - | - | - | - |
| Goosegrass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Johnsongrass | 30 | 0 | 0 | 70 | 0 | 0 | 0 | 30 | 65 | 0 | 0 | 20 | 0 | 0 |
| Kochia | 100 | 95 | 65 | 100 | 100 | 5 | 40 | 95 | 100 | 80 | 75 | 95 | 100 | 100 |
| Lambsquarters | 100 | 100 | 90 | 100 | 95 | 5 | 50 | 75 | 95 | 60 | 70 | 100 | 100 | 100 |
| Morningglory | 100 | 75 | 60 | 15 | 95 | 0 | - | 95 | 95 | 70 | 0 | 90 | 95 | 95 |
| Nutsedge, Yellow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oat, Wild | - | 55 | 30 | 60 | - | - | - | - | - | - | - | - | - | - |
| Pigweed | 90 | 80 | 65 | 100 | 85 | 0 | 20 | 70 | 70 | 65 | 80 | 65 | 90 | 65 |
| Ragweed | 100 | 85 | 75 | 100 | 90 | 0 | 25 | 60 | 80 | 45 | 65 | 75 | 85 | 85 |
| Ryegrass, Italian | - | 45 | 35 | 45 | - | - | - | - | - | - | - | - | - | - |
| Soybean | 100 | 100 | 75 | 100 | 95 | 40 | 25 | 95 | 100 | 70 | 80 | 95 | 95 | 95 |
| Surinam Grass | 90 | 55 | 0 | 60 | 0 | 0 | 0 | 40 | 65 | 0 | 0 | 0 | 0 | 0 |
| Velvetleaf | 85 | 70 | 55 | 80 | 55 | 0 | 0 | 60 | 75 | 65 | 60 | 65 | 60 | 50 |
| Wheat | - | 60 | 0 | 50 | - | - | - | - | - | - | - | - | - | - |
| Windgrass | - | 65 | 30 | 60 | - | - | - | - | - | - | - | - | - | - |

| Table C | Compound |
|---|---|
| 62 g ai/ha | 19 |
| Postemergence | |
| Barley | 35 |
| Bermudagrass | 30 |
| Blackgrass | 65 |
| Brome, Downy | 50 |
| Canarygrass | 60 |
| Chickweed | 5 |
| Cocklebur | 50 |
| Corn | 0 |
| Crabgrass | 70 |
| Cupgrass, Woolly | 65 |
| Foxtail, Giant | 40 |
| Foxtail, Green | 45 |
| Goosegrass | 0 |
| Johnsongrass | 0 |
| Kochia | 90 |
| Lambsquarters | 90 |
| Morningglory | 80 |
| Nutsedge, Yellow | 0 |
| Oat, Wild | 60 |
| Pigweed | 65 |
| Ragweed | 70 |

| | |
|---|---|
| Ryegrass, Italian | 65 |
| Soybean | 75 |
| Surinam Grass | 45 |
| Velvetleaf | 50 |
| Wheat | 40 |
| Windgrass | 60 |

| Table C | | | | Compounds | | | | |
|---|---|---|---|---|---|---|---|---|
| 31 g ai/ha | 2 | 3 | 6 | 9 | 11 | 16 | 17 | 19 |
| Postemergence | | | | | | | | |
| Barley | 0 | 0 | - | - | - | - | - | 25 |
| Bermudagrass | 15 | 0 | 0 | 60 | 0 | 0 | 0 | 5 |
| Blackgrass | 60 | 0 | - | - | - | - | - | 60 |
| Brome, Downy | 20 | 20 | - | - | - | - | - | 0 |
| Canarygrass | 30 | 10 | - | - | - | - | - | 60 |
| Chickweed | 60 | 0 | 0 | 15 | 0 | 0 | 0 | 0 |
| Cocklebur | 65 | 60 | 0 | 40 | 0 | 75 | 95 | 25 |
| Corn | 15 | 0 | 0 | 45 | 0 | 0 | 0 | 0 |
| Crabgrass | 40 | 0 | 0 | 60 | 0 | 0 | 0 | 40 |
| Cupgrass, Woolly | 40 | 0 | 0 | 40 | 0 | 0 | 0 | 25 |
| Foxtail, Giant | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 5 |
| Foxtail, Green | 55 | 20 | - | - | - | - | - | 35 |
| Goosegrass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Johnsongrass | 0 | 0 | 0 | 55 | 0 | 0 | 0 | 0 |
| Kochia | 85 | 20 | 0 | 95 | 65 | 95 | 100 | 90 |
| Lambsquarters | 100 | 75 | 5 | 90 | 60 | 95 | 95 | 90 |
| Morningglory | 70 | 45 | 0 | 90 | 0 | 85 | 95 | 55 |
| Nutsedge, Yellow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oat, Wild | 20 | 30 | - | - | - | - | - | 40 |
| Pigweed | 65 | 60 | 0 | 55 | 70 | 85 | 45 | 50 |
| Ragweed | 65 | 55 | 0 | 70 | 45 | 60 | 65 | 40 |
| Ryegrass, Italian | 35 | 35 | - | - | - | - | - | 65 |
| Soybean | 100 | 60 | 15 | 95 | 60 | 85 | 85 | 55 |
| Surinam Grass | 0 | 0 | 0 | 45 | 0 | 0 | 0 | 25 |
| Velvetleaf | 65 | 25 | 0 | 0 | 50 | 55 | 25 | 40 |
| Wheat | 20 | 0 | - | - | - | - | - | 30 |
| Windgrass | 65 | 10 | - | - | - | - | - | 40 |

| Table C | Compounds | | |
|---|---|---|---|
| 16 g ai/ha | 6 | 11 | 19 |
| Postemergence | | | |
| Barley | - | - | 25 |
| Bermudagrass | 0 | 0 | 0 |
| Blackgrass | - | - | 55 |
| Brome, Downy | - | - | 0 |
| Canarygrass | - | - | 45 |
| Chickweed | - | 0 | 0 |
| Cocklebur | 0 | 0 | 25 |
| Corn | 0 | 0 | 0 |
| Crabgrass | 0 | 0 | 20 |
| Cupgrass, Woolly | 0 | 0 | 0 |
| Foxtail, Giant | 0 | 0 | 0 |
| Foxtail, Green | - | - | 30 |
| Goosegrass | 0 | 0 | 0 |
| Johnsongrass | 0 | 0 | 0 |
| Kochia | 0 | 40 | 80 |
| Lambsquarters | 0 | 50 | 70 |
| Morningglory | 0 | 0 | - |
| Nutsedge, Yellow | 0 | 0 | 0 |
| Oat, Wild | - | - | 40 |
| Pigweed | 0 | 60 | 50 |
| Ragweed | 0 | 15 | 35 |
| Ryegrass, Italian | - | - | 65 |
| Soybean | 5 | 45 | 45 |
| Surinam Grass | 0 | 0 | 0 |
| Velvetleaf | 0 | 20 | 30 |
| Wheat | - | - | 10 |
| Windgrass | - | - | 40 |

| Table C | Compounds | | | | | |
|---|---|---|---|---|---|---|
| 500 g ai/ha | 1 | 4 | 5 | 8 | 10 | 15 |
| Preemergence | | | | | | |
| Bermudagrass | 90 | 95 | 70 | 100 | 0 | 70 |
| Cocklebur | 100 | 100 | 100 | 100 | 100 | 100 |
| Corn | 70 | 90 | 50 | 75 | 0 | 60 |
| Crabgrass | 95 | 95 | 60 | 0 | 0 | 100 |
| Cupgrass, Woolly | 95 | 95 | 0 | 100 | 0 | 95 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Foxtail, Giant | 90 | 85 | 60 | 0 | 0 | 80 |
| Goosegrass | 70 | 65 | 40 | 45 | 0 | 0 |
| Johnsongrass | 90 | 95 | 70 | 20 | 0 | 95 |
| Kochia | 100 | 100 | 100 | 100 | 65 | 100 |
| Lambsquarters | 100 | 100 | 100 | 100 | 95 | 100 |
| Morningglory | 100 | 100 | 100 | 100 | 100 | 100 |
| Nightshade | 100 | 100 | 100 | - | 95 | 100 |
| Nutsedge, Yellow | 50 | 80 | 0 | 100 | - | 20 |
| Pigweed | 100 | 100 | 100 | 95 | 85 | 100 |
| Ragweed | 100 | 100 | 100 | 100 | 85 | 100 |
| Soybean | 100 | 100 | 100 | 100 | - | 100 |
| Sunflower | 100 | 100 | 100 | 100 | 0 | 100 |
| Surinam Grass | 90 | 100 | 0 | 100 | 0 | 95 |
| Velvetleaf | 100 | 100 | 90 | 100 | 60 | 100 |

Table C

| | Compounds | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 250 g ai/ha | 1 | 2 | 3 | 4 | 5 | 8 | 9 | 10 | 12 | 13 | 15 | 16 | 17 |
| Preemergence | | | | | | | | | | | | | |
| Bermudagrass | 70 | 0 | 0 | 45 | 30 | 100 | 100 | 0 | 20 | 0 | 0 | 0 | 0 |
| Cocklebur | 100 | 100 | 70 | 100 | 100 | 100 | 100 | 0 | 90 | 95 | 100 | 100 | 100 |
| Corn | 50 | 0 | 0 | 75 | 20 | 10 | 75 | 0 | - | 30 | 45 | 75 | 75 |
| Crabgrass | 90 | 50 | 0 | 85 | 20 | 0 | 100 | 0 | 0 | 0 | 95 | 95 | 80 |
| Cupgrass, Woolly | 90 | 45 | 0 | 95 | 0 | 100 | 100 | 0 | 100 | 0 | 85 | 65 | 85 |
| Foxtail, Giant | 90 | 30 | 0 | 75 | 10 | 0 | 80 | 0 | 0 | 5 | 65 | 75 | 75 |
| Goosegrass | 10 | 60 | 0 | 55 | 0 | 35 | 50 | 0 | 0 | 0 | 0 | 0 | 0 |
| Johnsongrass | 80 | 40 | 0 | 90 | 60 | 0 | 90 | 0 | 5 | 45 | 75 | 80 | 75 |
| Kochia | 100 | 100 | 30 | 100 | 100 | 100 | 100 | 45 | 85 | 85 | 100 | 100 | 85 |
| Lambsquarters | 100 | 100 | 80 | 100 | 100 | 90 | 100 | 65 | 70 | 90 | 100 | 100 | 100 |
| Morningglory | 100 | 100 | 35 | 100 | 90 | 100 | 100 | 0 | 90 | 90 | 100 | 100 | 100 |
| Nightshade | 100 | 100 | 20 | 100 | 100 | - | - | 20 | 80 | 90 | 100 | 100 | 100 |
| Nutsedge, Yellow | 50 | 0 | 0 | 15 | 0 | 100 | 100 | - | 0 | 0 | 0 | 0 | 0 |
| Pigweed | 100 | 100 | 80 | 100 | 100 | 90 | 100 | 70 | 85 | 90 | 100 | 100 | 100 |
| Ragweed | 100 | 0 | 45 | 100 | 100 | 100 | 100 | 55 | 85 | 85 | 100 | 100 | 100 |
| Soybean | 100 | 100 | 20 | 100 | 98 | 100 | 100 | - | 70 | 90 | 95 | 100 | 100 |
| Sunflower | 100 | 100 | 0 | 100 | 100 | 100 | 100 | 0 | 85 | 90 | 100 | 100 | 100 |
| Surinam Grass | 90 | 0 | 0 | 85 | 0 | 100 | 100 | 0 | 0 | 10 | 75 | 80 | 0 |
| Velvetleaf | 95 | 90 | 35 | 95 | 90 | 100 | 100 | 0 | 70 | 90 | 100 | 100 | 100 |

| Table C | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 g ai/ha | 1 | 2 | 3 | 4 | 5 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 17 |
| Preemergence | | | | | | | | | | | | | | |
| Bermudagrass | 50 | 0 | 0 | 20 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cocklebur | 100 | 80 | 55 | 95 | 90 | 85 | 100 | 0 | 0 | 85 | 90 | 90 | 95 | 95 |
| Corn | 0 | – | 0 | 0 | 5 | 0 | 60 | 0 | 0 | 60 | 10 | 15 | 20 | 35 |
| Crabgrass | 60 | 0 | 0 | 65 | 0 | 0 | 95 | 0 | 60 | 0 | 0 | 95 | 65 | 20 |
| Cupgrass, Woolly | 60 | 0 | 0 | 80 | 0 | 65 | 95 | 0 | 0 | 10 | 0 | 20 | 15 | 20 |
| Foxtail, Giant | 30 | 0 | 0 | 40 | 0 | 0 | 75 | 0 | 20 | 0 | 0 | 0 | 0 | 20 |
| Goosegrass | 0 | 0 | 0 | 25 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Johnsongrass | 30 | 0 | 0 | 70 | 20 | 0 | 65 | 0 | 75 | 5 | 5 | 65 | 65 | 55 |
| Kochia | 100 | 95 | 20 | 100 | 95 | 85 | 100 | 0 | 60 | 50 | 80 | 100 | 100 | 25 |
| Lambsquarters | 100 | 100 | 0 | 100 | 95 | 20 | 100 | 50 | 85 | 40 | 90 | 100 | 100 | 100 |
| Morningglory | 100 | 100 | 20 | 100 | 80 | 100 | 100 | 0 | 0 | 60 | 85 | 100 | 100 | 100 |
| Nightshade | 100 | 100 | 0 | 100 | 100 | – | – | – | – | 60 | 90 | 100 | 95 | 95 |
| Nutsedge, Yellow | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | – | 0 | 0 | 0 | 0 | 0 |
| Pigweed | 100 | 95 | 65 | 100 | 90 | 85 | 100 | 55 | 90 | 50 | 85 | 100 | 100 | 100 |
| Ragweed | 100 | 0 | 0 | 100 | 90 | 100 | 100 | 0 | 45 | 20 | 70 | 95 | 95 | 95 |
| Soybean | 100 | 90 | 15 | 100 | 90 | 100 | 100 | – | 55 | – | 90 | 90 | 100 | 95 |
| Sunflower | 100 | 100 | 0 | 100 | 90 | 40 | 100 | 0 | 0 | 0 | 60 | 100 | 100 | 100 |
| Surinam Grass | 35 | 0 | 0 | 65 | 0 | 100 | 100 | 0 | 100 | 0 | 0 | 65 | 15 | 0 |
| Velvetleaf | 90 | 75 | 20 | 95 | 85 | 75 | 100 | 0 | 0 | 50 | 80 | 95 | 95 | 100 |

| Table C | Compound |
|---|---|
| 125 g ai/ha | 19 |
| Preemergence | |
| Bermudagrass | 0 |
| Cocklebur | 80 |
| Corn | 0 |
| Crabgrass | 0 |
| Cupgrass, Woolly | 0 |
| Foxtail, Giant | 0 |
| Goosegrass | 0 |
| Johnsongrass | 55 |
| Kochia | 90 |
| Lambsquarters | 100 |
| Morningglory | 90 |
| Nightshade | 100 |
| Nutsedge, Yellow | 0 |

| | |
|---|---|
| Pigweed | 95 |
| Ragweed | 80 |
| Soybean | 90 |
| Sunflower | 90 |
| Surinam Grass | 10 |
| Velvetleaf | 65 |

| Table C | Compounds | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 g ai/ha | 1 | 2 | 3 | 4 | 5 | 8 | 9 | 10 | 11 | 12 | 13 | 15 | 16 | 17 |
| Preemergence | | | | | | | | | | | | | | |
| Bermudagrass | 0 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cocklebur | 90 | - | 30 | 80 | 10 | - | 80 | - | 0 | 50 | 60 | 65 | 95 | 90 |
| Corn | 0 | 0 | 0 | - | 5 | 0 | 5 | 0 | 0 | 30 | 5 | 0 | 15 | 20 |
| Crabgrass | 10 | 0 | 0 | 40 | 0 | 0 | 95 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cupgrass, Woolly | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Foxtail, Giant | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Goosegrass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Johnsongrass | 0 | 0 | 0 | 50 | 5 | 0 | 45 | 0 | 0 | 0 | 0 | 20 | 40 | 0 |
| Kochia | 95 | 90 | 0 | 95 | 80 | 50 | 95 | 0 | 0 | 50 | 60 | 95 | 95 | 0 |
| Lambsquarters | 95 | 100 | 0 | 95 | 95 | 0 | 100 | 0 | 40 | 10 | 85 | 95 | 95 | 95 |
| Morningglory | 90 | 100 | 0 | 100 | 50 | 20 | 100 | 0 | 0 | 60 | 65 | 95 | 95 | 95 |
| Nightshade | 100 | 20 | 0 | 100 | 100 | - | - | - | - | 50 | 0 | 95 | 90 | 80 |
| Nutsedge, Yellow | 0 | 0 | 0 | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pigweed | 90 | 95 | 50 | 95 | 60 | 65 | 95 | 20 | 65 | 50 | 60 | 90 | 95 | 100 |
| Ragweed | 95 | 0 | 0 | 100 | 85 | 100 | 100 | 0 | 20 | 10 | 60 | 90 | 90 | 80 |
| Soybean | 85 | 75 | 0 | 95 | 85 | 100 | 100 | 0 | - | 50 | 60 | 75 | 85 | 90 |
| Sunflower | 80 | 100 | 0 | 100 | 60 | 20 | 100 | 0 | 0 | 0 | 50 | 65 | 85 | 95 |
| Surinam Grass | 0 | 0 | 0 | 0 | 0 | 0 | 100 | - | 100 | - | 0 | 15 | 0 | 0 |
| Velvetleaf | 80 | 50 | 0 | 75 | 85 | 65 | 95 | 0 | 0 | 5 | 60 | 80 | 90 | 80 |

| Table C | Compound |
|---|---|
| 62 g ai/ha | 19 |
| Preemergence | |
| Bermudagrass | 0 |
| Cocklebur | 65 |
| Corn | 0 |
| Crabgrass | 0 |
| Cupgrass, Woolly | 0 |
| Foxtail, Giant | 0 |

| | |
|---|---|
| Goosegrass | 0 |
| Johnsongrass | 35 |
| Kochia | 85 |
| Lambsquarters | 100 |
| Morningglory | 90 |
| Nightshade | 100 |
| Nutsedge, Yellow | 0 |
| Pigweed | 70 |
| Ragweed | 70 |
| Soybean | 85 |
| Sunflower | 70 |
| Surinam Grass | 0 |
| Velvetleaf | 40 |

| Table C | Compounds | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 31 g ai/ha | 2 | 3 | 9 | 11 | 12 | 13 | 16 | 17 | 19 |
| Preemergence | | | | | | | | | |
| Bermudagrass | 0 | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cocklebur | 60 | 0 | 75 | 0 | 50 | 40 | 45 | 75 | 30 |
| Corn | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Crabgrass | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cupgrass, Woolly | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Foxtail, Giant | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Goosegrass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Johnsongrass | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kochia | 75 | 0 | 95 | 0 | 0 | 45 | 90 | 0 | - |
| Lambsquarters | 90 | 0 | 95 | 0 | 0 | 50 | 95 | 95 | 100 |
| Morningglory | 100 | 0 | 100 | 0 | 30 | 60 | 65 | 70 | 10 |
| Nightshade | 0 | 0 | - | - | - | 0 | 55 | - | 40 |
| Nutsedge, Yellow | 0 | 0 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pigweed | 90 | 20 | 95 | 0 | 10 | 50 | 85 | 95 | 45 |
| Ragweed | 0 | 0 | 100 | 0 | - | 45 | 45 | 70 | 55 |
| Soybean | 15 | 0 | 100 | - | - | 0 | 75 | 70 | 25 |
| Sunflower | 20 | 0 | 100 | 0 | 0 | 5 | 20 | 60 | 25 |
| Surinam Grass | 0 | 0 | 95 | 0 | 0 | 0 | 0 | 0 | - |
| Velvetleaf | 20 | 0 | 70 | 0 | 0 | 60 | 25 | 20 | 35 |

| Table C | Compounds | |
|---|---|---|
| 16 g ai/ha | 11 | 19 |
| Preemergence | | |
| Bermudagrass | 0 | 0 |
| Cocklebur | 0 | 15 |
| Corn | 0 | 0 |
| Crabgrass | 0 | 0 |
| Cupgrass, Woolly | 0 | 0 |
| Foxtail, Giant | 0 | 0 |
| Goosegrass | 0 | 0 |
| Johnsongrass | 0 | 0 |
| Kochia | 0 | 35 |
| Lambsquarters | 0 | 75 |
| Morningglory | 0 | 10 |
| Nightshade | - | 0 |
| Nutsedge, Yellow | 0 | 0 |
| Pigweed | 0 | 35 |
| Ragweed | 0 | 55 |
| Soybean | - | 0 |
| Sunflower | 0 | 10 |
| Surinam Grass | 0 | 0 |
| Velvetleaf | 0 | 25 |

TEST D

Seeds of plant species selected from bermudagrass (*Cynodon dactylon*), Kentucky (KY) bluegrass (*Poa pratensis*), bentgrass (*Agrostis palustris*), fine fescue (*Festuca rubra*), large crabgrass (*Digitaria sanguinalis*), goosegrass (*Eleusine indica*), dallisgrass (*Paspalum dilatatum*), annual bluegrass (*Poa annua*), common chickweed (*Stellaria media*), dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*), and yellow nutsedge (*Cyperus esculentus*) were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these weed species were treated with postemergence applications of some of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Treated plants and controls were maintained in a greenhouse for 12 to 14 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table D, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

| Table D | Compound |
|---|---|
| 500 g ai/ha | 1 |
| Postemergence | |
| Bentgrass | 70 |
| Bermudagrass | 70 |
| Bluegrass | 95 |
| Bluegrass, KY | 30 |
| Chickweed | 100 |
| Clover, White | 100 |
| Crabgrass | 90 |
| Dallisgrass | 60 |
| Dandelion | 95 |
| Fescue, Hard | 0 |
| Goosegrass | 50 |
| Nutsedge, Yellow | 15 |

| Table D | Compound |
|---|---|
| 250 g ai/ha | 1 |
| Postemergence | |
| Bentgrass | 50 |
| Bermudagrass | 50 |
| Bluegrass | 70 |
| Bluegrass, KY | 0 |
| Chickweed | 85 |
| Clover, White | 100 |
| Crabgrass | 75 |
| Dallisgrass | 75 |
| Dandelion | 85 |
| Fescue, Hard | 0 |
| Goosegrass | 40 |
| Nutsedge, Yellow | 15 |

| Table D | Compound |
|---|---|
| 125 g ai/ha | 1 |
| Postemergence | |
| Bentgrass | 50 |
| Bermudagrass | 40 |
| Bluegrass | 45 |
| Bluegrass, KY | 0 |
| Chickweed | 85 |
| Clover, White | 100 |
| Crabgrass | 70 |
| Dallisgrass | 15 |
| Dandelion | 75 |
| Fescue, Hard | 0 |
| Goosegrass | 35 |
| Nutsedge, Yellow | 10 |

| Table D | Compound |
|---|---|
| 62 g ai/ha | 1 |
| Postemergence | |
| Bentgrass | 30 |
| Bermudagrass | 20 |
| Bluegrass, KY | 0 |
| Chickweed | 80 |
| Clover, White | 90 |
| Crabgrass | 45 |
| Dallisgrass | 0 |
| Dandelion | 75 |
| Fescue, Hard | 0 |
| Goosegrass | 10 |
| Nutsedge, Yellow | 10 |

| Table D | Compound |
|---|---|
| 31 g ai/ha | 1 |
| Postemergence | |
| Bentgrass | 0 |
| Bermudagrass | 0 |
| Bluegrass | 35 |
| Bluegrass, KY | 20 |
| Chickweed | 0 |
| Clover, White | 70 |
| Crabgrass | 0 |
| Dallisgrass | 0 |
| Dandelion | 50 |
| Fescue, Hard | 0 |
| Goosegrass | 5 |
| Nutsedge, Yellow | 0 |

| Table D | Compound |
|---|---|
| 500 g ai/ha | 1 |
| Preemergence | |
| Bentgrass | 100 |
| Bermudagrass | 90 |
| Bluegrass | 70 |
| Bluegrass, KY | 80 |
| Chickweed | 100 |
| Clover, White | 100 |
| Crabgrass | 100 |
| Dallisgrass | 95 |
| Dandelion | 100 |
| Fescue, Hard | 90 |
| Goosegrass | 85 |
| Nutsedge, Yellow | 70 |

| Table D | Compound |
|---|---|
| 250 g ai/ha | 1 |
| Preemergence | |
| Bentgrass | 90 |
| Bermudagrass | 80 |
| Bluegrass | 70 |
| Bluegrass, KY | 40 |
| Chickweed | 100 |
| Clover, White | 100 |
| Crabgrass | 95 |
| Dallisgrass | 70 |
| Dandelion | 100 |
| Fescue, Hard | 60 |
| Goosegrass | 65 |
| Nutsedge, Yellow | 25 |

| Table D | Compound |
|---|---|
| 125 g ai/ha | 1 |
| Preemergence | |
| Bentgrass | 60 |
| Bermudagrass | 50 |
| Bluegrass | 45 |
| Bluegrass, KY | 30 |
| Chickweed | 100 |
| Clover, White | 100 |
| Crabgrass | 85 |
| Dallisgrass | 45 |
| Dandelion | 100 |
| Fescue, Hard | 60 |
| Goosegrass | 30 |
| Nutsedge, Yellow | 30 |

| Table D | Compound |
|---|---|
| 62 g ai/ha | 1 |
| Preemergence | |
| Bentgrass | 60 |
| Bermudagrass | 40 |
| Bluegrass | 65 |
| Bluegrass, KY | 30 |

| Table D | Compound |
|---|---|
| 31 g ai/ha | 1 |
| Preemergence | |
| Bentgrass | 50 |
| Bermudagrass | 10 |
| Bluegrass | 20 |
| Bluegrass, KY | 0 |

| | |
|---|---|
| Chickweed | 100 |
| Clover, White | 100 |
| Crabgrass | 40 |
| Dallisgrass | 35 |
| Dandelion | 95 |
| Fescue, Hard | 60 |
| Goosegrass | 40 |
| Nutsedge, Yellow | 15 |

| | |
|---|---|
| Chickweed | 80 |
| Clover, White | 80 |
| Crabgrass | 15 |
| Dallisgrass | 10 |
| Dandelion | 35 |
| Fescue, Hard | 50 |
| Goosegrass | 30 |
| Nutsedge, Yellow | 0 |

TEST E

Seeds of plant species selected from bermudagrass (*Cynodon dactylon*), Surinam grass (*Brachiaria decumbens*), large crabgrass (*Digitaria sanguinalis*), green foxtail (*Setaria viridis*), goosegrass (*Eleusine indica*), johnsongrass (*Sorghum halepense*), kochia (*Kochia scoparia*), pitted morningglory (*Ipomoea lacunosa*), purple nutsedge (*Cyperus rotundus*), common ragweed (*Ambrosia elatior*), mustard (*Brassica nigra*), guineagrass (*Panicum maximum*), dallisgrass (*Paspalum dilatatum*), barnyardgrass (*Echinochloa crus-galli*), southern sandbur (*Cenchrus echinatus*), common sowthistle (*Sonchus oleraceous*), prickly sida (*Sida spinosa*), Italian ryegrass (*Lolium multiflorum*), common purslane (*Portulaca oleracea*), broadleaf Signalgrass (*Brachiaria platyphylla*), common groundsel (*Senecio vulgaris*), common chickweed (*Stellaria media*), tropical spiderwort (*Commelina benghalensis*), annual bluegrass (Poa annua), downy bromegrass (*Bromus tectorum*), itchgrass (*Rottboellia cochinchinensis*), quackgrass (*Elytrigia repens*), Canada horseweed (*Conyza canadensis*), field bindweed (*Convolvulus arvensis*), spanishneedles (*Bidens bipinnata*), common mallow (*Malva sylvestris*), and Russian thistle (*Salsola kali*) were planted and treated preemergence with test chemicals formulated in a non-phytotoxic solvent mixture which included a surfactant.

At the same time, plants selected from these weed species were treated with postemergence applications of some of the test chemicals formulated in the same manner. Plants ranged in height from 2 to 18 cm (1- to 4-leaf stage) for postemergence treatments. Treated plants and controls were maintained in a greenhouse for 12 to 14 days, after which time all species were compared to controls and visually evaluated. Plant response ratings, summarized in Table E, are based on a scale of 0 to 100 where 0 is no effect and 100 is complete control. A dash (–) response means no test result.

| Table E | Compound |
|---|---|
| 500 g ai/ha | 1 |
| Postemergence | |
| Barnyardgrass | 75 |
| Bermudagrass | 50 |

| Table E | Compound |
|---|---|
| 375 g ai/ha | 1 |
| Postemergence | |
| Barnyardgrass | 70 |
| Bermudagrass | 40 |

| | |
|---|---|
| Bindweed, Field | 95 |
| Black Mustard | 75 |
| Bluegrass | 50 |
| Brome, Downy | 80 |
| Crabgrass | 70 |
| Dallisgrass | 30 |
| Foxtail, Green | 60 |
| Goosegrass | 60 |
| Groundsel | 100 |
| Guineagrass | 95 |
| Horseweed | 100 |
| Itchgrass | 70 |
| Johnsongrass | 95 |
| Mallow | 95 |
| Morningglory | 100 |
| Nutsedge, Purple | 30 |
| Prickly Sida | 95 |
| Purslane | 100 |
| Quackgrass | 70 |
| Ragweed | 100 |
| Ryegrass, Italian | 40 |
| Sandbur | 95 |
| Signalgrass | 85 |
| Sowthistle | 100 |
| Spanishneedles | 95 |
| Spiderwort | 95 |
| Surinam Grass | 90 |

| | |
|---|---|
| Bindweed, Field | 95 |
| Black Mustard | 75 |
| Bluegrass | 50 |
| Brome, Downy | 70 |
| Chickweed | 100 |
| Crabgrass | 70 |
| Dallisgrass | 30 |
| Foxtail, Green | 50 |
| Goosegrass | 60 |
| Groundsel | 100 |
| Horseweed | 100 |
| Itchgrass | 60 |
| Johnsongrass | 95 |
| Kochia | 95 |
| Mallow | 95 |
| Morningglory | 100 |
| Nutsedge, Purple | 30 |
| Prickly Sida | 95 |
| Purslane | 100 |
| Quackgrass | 70 |
| Ragweed | 100 |
| Russian Thistle | 100 |
| Ryegrass, Italian | 40 |
| Sandbur | 95 |
| Signalgrass | 75 |
| Sowthistle | 95 |
| Spanishneedles | 95 |
| Spiderwort | 95 |
| Surinam Grass | 90 |

| Table E | Compound |
|---|---|
| 250 g ai/ha | 1 |
| Postemergence | |
| Barnyardgrass | 70 |
| Bermudagrass | 40 |
| Bindweed, Field | 95 |
| Black Mustard | 75 |
| Bluegrass | 40 |

| Table E | Compound |
|---|---|
| 125 g ai/ha | 1 |
| Postemergence | |
| Barnyardgrass | 60 |
| Bermudagrass | 25 |
| Bindweed, Field | 95 |
| Black Mustard | 75 |
| Bluegrass | 30 |

| | |
|---|---|
| Brome, Downy | 60 |
| Chickweed | 95 |
| Crabgrass | 70 |
| Dallisgrass | 30 |
| Foxtail, Green | 30 |
| Goosegrass | 60 |
| Groundsel | 95 |
| Guineagrass | 95 |
| Horseweed | 100 |
| Itchgrass | 60 |
| Johnsongrass | 95 |
| Mallow | 70 |
| Morningglory | 100 |
| Nutsedge, Purple | 20 |
| Prickly Sida | 90 |
| Purslane | 100 |
| Quackgrass | 60 |
| Ragweed | 95 |
| Russian Thistle | 100 |
| Ryegrass, Italian | 40 |
| Sandbur | 95 |
| Signalgrass | 75 |
| Sowthistle | 95 |
| Spanishneedles | 95 |
| Spiderwort | 95 |
| Surinam Grass | 85 |

| Table E | Compound |
|---|---|
| 62 g ai/ha | 1 |
| Postemergence | |
| Barnyardgrass | 60 |
| Bermudagrass | 25 |
| Bindweed, Field | 90 |
| Black Mustard | 60 |
| Bluegrass | 20 |
| Brome, Downy | 30 |
| Crabgrass | 50 |
| Dallisgrass | 10 |

| | |
|---|---|
| Brome, Downy | 30 |
| Chickweed | 95 |
| Crabgrass | 60 |
| Dallisgrass | 20 |
| Foxtail, Green | 20 |
| Goosegrass | 60 |
| Groundsel | 95 |
| Guineagrass | 70 |
| Horseweed | 70 |
| Itchgrass | 40 |
| Johnsongrass | 70 |
| Mallow | 60 |
| Morningglory | 100 |
| Nutsedge, Purple | 10 |
| Prickly Sida | 70 |
| Purslane | 100 |
| Quackgrass | 30 |
| Ragweed | 95 |
| Russian Thistle | 100 |
| Ryegrass, Italian | 10 |
| Sandbur | 60 |
| Signalgrass | 60 |
| Sowthistle | 95 |
| Spanishneedles | 95 |
| Spiderwort | 95 |
| Surinam Grass | 60 |

| Table E | Compounds | |
|---|---|---|
| 500 g ai/ha | 1 | 4 |
| Preemergence | | |
| Barnyardgrass | 70 | 100 |
| Bermudagrass | 70 | 100 |
| Bindweed, Field | 100 | 100 |
| Black Mustard | 100 | 100 |
| Bluegrass | 85 | 100 |
| Brome, Downy | 95 | 100 |
| Chickweed | 100 | 100 |
| Crabgrass | 90 | 100 |

| | |
|---|---|
| Foxtail, Green | 10 |
| Goosegrass | 20 |
| Groundsel | 60 |
| Guineagrass | 60 |
| Itchgrass | 20 |
| Johnsongrass | 70 |
| Mallow | 50 |
| Morningglory | 100 |
| Prickly Sida | 70 |
| Purslane | 80 |
| Quackgrass | 10 |
| Ragweed | 75 |
| Russian Thistle | 100 |
| Ryegrass, Italian | 0 |
| Sandbur | 30 |
| Signalgrass | 20 |
| Sowthistle | 95 |
| Spanishneedles | 80 |
| Spiderwort | 95 |
| Surinam Grass | 30 |

| Table E | Compound |
|---|---|
| 375 g ai/ha | 1 |
| Preemergence | |
| Barnyardgrass | 70 |
| Bermudagrass | 70 |
| Bindweed, Field | 100 |
| Black Mustard | 100 |
| Brome, Downy | 95 |
| Chickweed | 100 |
| Crabgrass | 90 |
| Dallisgrass | 95 |
| Foxtail, Green | 90 |
| Goosegrass | 50 |

| | | |
|---|---|---|
| Dallisgrass | 95 | 100 |
| Foxtail, Green | 90 | 100 |
| Goosegrass | 50 | 90 |
| Groundsel | 100 | 100 |
| Guineagrass | 100 | 100 |
| Horseweed | 100 | 100 |
| Itchgrass | 90 | 95 |
| Johnsongrass | 75 | 95 |
| Kochia | 100 | - |
| Mallow | 95 | 100 |
| Morningglory | 100 | 100 |
| Nutsedge, Purple | 100 | 100 |
| Prickly Sida | 100 | 100 |
| Purslane | 100 | 100 |
| Quackgrass | 95 | 100 |
| Ragweed | 100 | 100 |
| Russian Thistle | 100 | 100 |
| Ryegrass, Italian | 95 | 100 |
| Sandbur | 85 | 100 |
| Signalgrass | 95 | 95 |
| Sowthistle | 100 | 100 |
| Spanishneedles | 100 | 100 |
| Spiderwort | 100 | 100 |
| Surinam Grass | 100 | 95 |

| Table E | Compounds | |
|---|---|---|
| 250 g ai/ha | 1 | 4 |
| Preemergence | | |
| Barnyardgrass | 50 | 80 |
| Bermudagrass | 30 | 95 |
| Bindweed, Field | 100 | 100 |
| Black Mustard | 85 | 100 |
| Bluegrass | 85 | 80 |
| Brome, Downy | 95 | 100 |
| Chickweed | 95 | 100 |
| Crabgrass | 90 | 100 |
| Dallisgrass | 50 | 95 |
| Foxtail, Green | 50 | 100 |

| | |
|---|---|
| Groundsel | 100 |
| Guineagrass | 100 |
| Horseweed | 100 |
| Itchgrass | 85 |
| Johnsongrass | 75 |
| Kochia | 100 |
| Mallow | 95 |
| Morningglory | 100 |
| Nutsedge, Purple | 100 |
| Prickly Sida | 100 |
| Purslane | 100 |
| Quackgrass | 95 |
| Ragweed | 100 |
| Russian Thistle | 100 |
| Ryegrass, Italian | 95 |
| Sandbur | 85 |
| Signalgrass | 75 |
| Sowthistle | 100 |
| Spanishneedles | 100 |
| Spiderwort | 100 |
| Surinam Grass | 95 |

| | | |
|---|---|---|
| Goosegrass | 50 | 70 |
| Groundsel | 100 | 100 |
| Guineagrass | 85 | 100 |
| Horseweed | 100 | 100 |
| Itchgrass | 80 | 80 |
| Johnsongrass | 60 | 85 |
| Kochia | 100 | - |
| Mallow | 95 | 100 |
| Morningglory | 100 | 100 |
| Nutsedge, Purple | 100 | 100 |
| Prickly Sida | 100 | 100 |
| Purslane | 95 | 100 |
| Quackgrass | 90 | 100 |
| Ragweed | 100 | 100 |
| Russian Thistle | 100 | 100 |
| Ryegrass, Italian | 30 | 100 |
| Sandbur | 70 | 90 |
| Signalgrass | 75 | 95 |
| Sowthistle | 100 | 100 |
| Spanishneedles | 100 | 100 |
| Spiderwort | 100 | 100 |
| Surinam Grass | 95 | 80 |

| Table E | Compounds | |
|---|---|---|
| 125 g ai/ha | 1 | 4 |
| Preemergence | | |
| Barnyardgrass | 20 | 70 |
| Bermudagrass | 20 | 90 |
| Bindweed, Field | 100 | 100 |
| Black Mustard | 80 | 95 |
| Bluegrass | 30 | 60 |
| Brome, Downy | 20 | 70 |
| Chickweed | 95 | 100 |
| Crabgrass | 30 | 75 |
| Dallisgrass | 10 | 50 |
| Foxtail, Green | 10 | 70 |
| Goosegrass | - | 60 |
| Groundsel | 100 | 95 |

| Table E | Compounds | |
|---|---|---|
| 62 g ai/ha | 1 | 4 |
| Preemergence | | |
| Barnyardgrass | 0 | 50 |
| Bermudagrass | 10 | 20 |
| Bindweed, Field | 95 | 100 |
| Black Mustard | 30 | 95 |
| Bluegrass | 10 | 10 |
| Brome, Downy | 0 | 30 |
| Chickweed | 70 | 100 |
| Crabgrass | 20 | 60 |
| Dallisgrass | 0 | 0 |
| Foxtail, Green | 10 | 20 |
| Goosegrass | 0 | 10 |
| Groundsel | 60 | 95 |

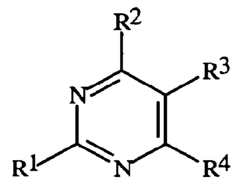
| | | |
|---|---|---|
| Guineagrass | 70 | 95 |
| Horseweed | 95 | 100 |
| Itchgrass | 30 | 70 |
| Johnsongrass | 40 | 75 |
| Kochia | 100 | - |
| Mallow | 80 | 100 |
| Morningglory | 100 | 100 |
| Nutsedge, Purple | 100 | 100 |
| Prickly Sida | 100 | 100 |
| Purslane | 60 | 100 |
| Quackgrass | 60 | 90 |
| Ragweed | 95 | 100 |
| Russian Thistle | 100 | 100 |
| Ryegrass, Italian | 10 | 60 |
| Sandbur | 30 | 80 |
| Signalgrass | 70 | 70 |
| Sowthistle | 100 | 100 |
| Spanishneedles | 100 | 100 |
| Spiderwort | 100 | 100 |
| Surinam Grass | 95 | 60 |

| | | |
|---|---|---|
| Guineagrass | 70 | 95 |
| Horseweed | 95 | 100 |
| Itchgrass | 10 | 70 |
| Johnsongrass | 20 | 60 |
| Kochia | 100 | - |
| Mallow | 50 | 100 |
| Morningglory | 95 | 100 |
| Nutsedge, Purple | 10 | 40 |
| Prickly Sida | 70 | 85 |
| Purslane | 10 | 60 |
| Quackgrass | 10 | 60 |
| Ragweed | 50 | 80 |
| Russian Thistle | 100 | - |
| Ryegrass, Italian | 0 | 30 |
| Sandbur | 0 | 30 |
| Signalgrass | 10 | 50 |
| Sowthistle | 95 | 100 |
| Spanishneedles | 100 | 100 |
| Spiderwort | 70 | 100 |
| Surinam Grass | 95 | 30 |

## CLAIMS

What is claimed is:

1. A compound selected from Formula **I**, an *N*-oxide or an agriculturally suitable salt thereof,



**I**

wherein

$R^1$ is cyclopropyl optionally substituted with 1–5 $R^5$, isopropyl optionally substituted with 1–5 $R^6$, or phenyl optionally substituted with 1–2 $R^7$; or $R^1$ is halogen, $OR^8$, $SR^9$ or $N(R^{10})R^{11}$;

$R^2$ is $CO_2R^{12}$, $CH_2OR^{13}$, CHO, $C(=NOR^{14})H$, $C(R^{15})(R^{16})CO_2R^{17}$ or $C(=O)N(R^{18})R^{19}$;

$R^3$ is halogen, cyano, nitro, $OR^{20}$, $SR^{21}$ or $N(R^{22})R^{23}$;

$R^4$ is $-N(R^{24})R^{25}$ or $-NO_2$;

each $R^5$ and $R^6$ is independently halogen, $C_1$–$C_2$ alkyl or $C_1$–$C_2$ haloalkyl;

each $R^7$ is independently halogen, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl, $C_1$–$C_3$ alkoxy, $C_1$–$C_3$ haloalkoxy, $C_1$–$C_3$ alkylthio or $C_1$–$C_3$ haloalkylthio;

$R^8$ is H, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl or phenyl optionally substituted with 1–2 $R^{26}$;

$R^9$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{10}$ is H or $C_1$–$C_4$ alkyl;

$R^{11}$ is $C_1$–$C_4$ alkyl;

or $R^{10}$ and $R^{11}$ are taken together as $-(CH_2)_m-$ or $-(CH_2)_2O(CH_2)_2-$;

$R^{12}$ is H; or a radical selected from $C_1$–$C_{14}$ alkyl, $C_3$–$C_{12}$ cycloalkyl, $C_4$–$C_{12}$ alkylcycloalkyl, $C_4$–$C_{12}$ cycloalkylalkyl, $C_2$–$C_{14}$ alkenyl and $C_2$–$C_{14}$ alkynyl, each radical optionally substituted with 1–3 $R^{27}$;

$R^{13}$ is H, $C_1$–$C_{10}$ alkyl optionally substituted with 1–3 $R^{28}$ or benzyl;

$R^{14}$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_4$ haloalkyl;

$R^{15}$ and $R^{16}$ are independently H, halogen, $C_1$–$C_4$ alkyl, $C_1$–$C_4$ haloalkyl, hydroxy or $C_1$–$C_4$ alkoxy;

$R^{17}$ is $C_1$–$C_{10}$ alkyl optionally substituted with 1–3 $R^{29}$ or benzyl;

$R^{18}$ and $R^{19}$ are independently H or $C_1$–$C_4$ alkyl;

$R^{20}$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{21}$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{22}$ and $R^{23}$ are independently H or $C_1$–$C_4$ alkyl;

$R^{24}$ is H, $C_1$–$C_4$ alkyl optionally substituted with 1–2 $R^{30}$, $C_2$–$C_4$ alkenyl optionally substituted with 1–2 $R^{31}$, or $C_2$–$C_4$ alkynyl optionally substituted with 1–2 $R^{32}$; or $R^{24}$ is $C(=O)R^{33}$, nitro, $OR^{34}$, $S(O)_2R^{35}$ or $N(R^{36})R^{37}$;

$R^{25}$ is H, $C_1$–$C_4$ alkyl optionally substituted with 1–2 $R^{30}$ or $C(=O)R^{33}$; or

$R^{24}$ and $R^{25}$ are taken together as a radical selected from $-(CH_2)_4-$, $-(CH_2)_5-$, $-CH_2CH=CHCH_2-$ and $-(CH_2)_2O(CH_2)_2-$, each radical optionally substituted with 1–2 $R^{38}$; or

$R^{24}$ and $R^{25}$ are taken together as $=C(R^{39})N(R^{40})R^{41}$ or $=C(R^{42})OR^{43}$;

each $R^{26}$ is independently halogen, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl, $C_1$–$C_3$ alkoxy, $C_1$–$C_3$ haloalkoxy, $C_1$–$C_3$ alkylthio or $C_1$–$C_3$ haloalkylthio;

each $R^{27}$ is independently halogen, hydroxycarbonyl, $C_2$–$C_4$ alkoxycarbonyl, hydroxy, $C_1$–$C_4$ alkoxy, $C_1$–$C_4$ haloalkoxy, $C_1$–$C_4$ alkylthio, $C_1$–$C_4$ haloalkylthio, amino, $C_1$–$C_4$ alkylamino, $C_1$–$C_4$ dialkylamino, $-CH[O(CH_2)_n]$ or phenyl optionally substituted with 1–3 $R^{44}$; or

two $R^{27}$ are taken together with the carbon atom to which they are attached to form a carbonyl moiety;

each $R^{28}$ and $R^{29}$ is independently halogen, $C_1$–$C_4$ alkoxy, $C_1$–$C_4$ haloalkoxy, $C_1$–$C_4$ alkylthio, $C_1$–$C_4$ haloalkylthio, amino, $C_1$–$C_4$ alkylamino or $C_1$–$C_4$ dialkylamino;

each $R^{30}$, $R^{31}$ and $R^{32}$ is independently halogen, hydroxy, $C_1$–$C_4$ alkoxy, $C_1$–$C_4$ haloalkoxy, $C_1$–$C_4$ alkylthio, $C_1$–$C_4$ haloalkylthio, amino, $C_1$–$C_4$ alkylamino, $C_1$–$C_4$ dialkylamino or $C_2$–$C_4$ alkoxycarbonyl;

each $R^{33}$ is independently H, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl, $C_1$–$C_4$ alkoxy, phenoxy or benzyloxy;

$R^{34}$ is H, $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{35}$ is $C_1$–$C_4$ alkyl or $C_1$–$C_3$ haloalkyl;

$R^{36}$ and $R^{37}$ are independently H or $C_1$–$C_4$ alkyl;

each $R^{38}$ is independently halogen, $C_1$–$C_3$ alkyl, $C_1$–$C_3$ alkoxy, $C_1$–$C_3$ haloalkoxy, $C_1$–$C_3$ alkylthio, $C_1$–$C_3$ haloalkylthio, amino, $C_1$–$C_3$ alkylamino, $C_1$–$C_4$ dialkylamino or $C_2$–$C_4$ alkoxycarbonyl;

$R^{39}$ is H or $C_1$–$C_4$ alkyl;

$R^{40}$ and $R^{41}$ are independently H or $C_1$–$C_4$ alkyl; or

$R^{40}$ and $R^{41}$ are taken together as $-(CH_2)_4-$, $-(CH_2)_5-$, $-CH_2CH=CHCH_2-$ or $-(CH_2)_2O(CH_2)_2-$;

$R^{42}$ is H or $C_1$–$C_4$ alkyl;

$R^{43}$ is H or $C_1$–$C_4$ alkyl;

each $R^{44}$ is independently halogen, $C_1$–$C_4$ alkyl, $C_1$–$C_3$ haloalkyl, hydroxy, $C_1$–$C_4$ alkoxy, $C_1$–$C_3$ haloalkoxy, $C_1$–$C_4$ alkylthio, $C_1$–$C_3$ haloalkylthio, amino, $C_1$–$C_3$ alkylamino, $C_1$–$C_4$ dialkylamino or nitro;

m is an integer from 2 to 5; and

n is an integer from 1 to 4;

provided that:

(a) when $R^2$ is $CH_2OR^{13}$, then $R^1$ is other than $SCH_3$, and $R^{24}$ and $R^{25}$ are H;

(b) when $R^1$ and $R^3$ are halogen, then $R^4$ is $NH_2$; and

(c) when $R^1$ is $SCH_3$, then $R^3$ is Cl.

2. The compound of Claim 1 wherein $R^1$ is cyclopropyl; and $R^4$ is $-N(R^{24})R^{25}$.

3. The compound of Claim 2 wherein $R^2$ is $CO_2R^{12}$; and $R^{24}$ and $R^{25}$ are H.

4. The compound of Claim 2 wherein $R^3$ is halogen.

5. The compound of Claim 4 wherein $R^2$ is $CO_2R^{12}$, $CH_2OR^{13}$, CHO or $CH_2CO_2R^{17}$.

6. The compound of Claim 5 wherein $R^{24}$ is H or $C_1$–$C_4$ alkyl optionally substituted with $R^{30}$; $R^{25}$ is H or $C_1$–$C_2$ alkyl; or $R^{24}$ and $R^{25}$ are taken together as $=C(R^{39})N(R^{40})R^{41}$.

7. The compound of Claim 6 wherein $R^2$ is $CO_2R^{12}$; and $R^{12}$ is H or $C_1$–$C_4$ alkyl.

8. The compound of Claim 7 wherein $R^{24}$ and $R^{25}$ are H.

9. The compound of Claim 1 selected from the group consisting of:

methyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate,

ethyl 6-amino-5-bromo-2-cyclopropyl-4-pyrimidinecarboxylate,

methyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate, and

ethyl 6-amino-5-chloro-2-cyclopropyl-4-pyrimidinecarboxylate.

10. A herbicidal composition comprising a herbicidally effective amount of a compound of Claim 1 and at least one of a surfactant, a solid diluent or a liquid diluent.

11. A method for controlling the growth of undesired vegetation comprising contacting the vegetation or its environment with a herbicidally effective amount of a compound of Claim 1.

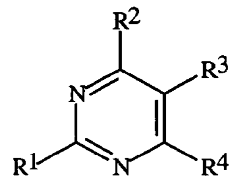
12. A herbicidal composition comprising a herbicidally effective amount of a compound of Claim 1, an effective amount of at least one additional active ingredient selected from the group consisting of an other herbicide and a herbicide safener, and at least one of a surfactant, a solid diluent or a liquid diluent.

# TITLE

# HERBICIDAL PYRIMIDINES

## ABSTRACT OF THE DISCLOSURE

Compounds of Formula **I**, and their *N*-oxides and agriculturally suitable salts, are disclosed which are useful for controlling undesired vegetation




**I**

wherein

$R^1$ is cyclopropyl optionally substituted with 1–5 $R^5$, isopropyl optionally substituted with 1–5 $R^6$, or phenyl optionally substituted with 1–2 $R^7$; or $R^1$ is halogen, $OR^8$, $SR^9$ or $N(R^{10})R^{11}$;

$R^2$ is $CO_2R^{12}$, $CH_2OR^{13}$, CHO, $C(=NOR^{14})H$, $C(R^{15})(R^{16})CO_2R^{17}$ or $C(=O)N(R^{18})R^{19}$;

$R^3$ is halogen, cyano, nitro, $OR^{20}$, $SR^{21}$ or $N(R^{22})R^{23}$;

$R^4$ is $-N(R^{24})R^{25}$ or $-NO_2$;

and $R^5$, $R^6$, $R^7$, $R^8$, $R^9$, $R^{10}$, $R^{11}$, $R^{12}$, $R^{13}$, $R^{14}$, $R^{15}$, $R^{16}$, $R^{17}$, $R^{18}$, $R^{19}$, $R^{20}$, $R^{21}$, $R^{22}$, $R^{23}$, $R^{24}$ and $R^{25}$ are as defined in the disclosure.

Also disclosed are compositions comprising the compounds of Formula **I** and a method for controlling undesired vegetation which involves contacting the vegetation or its environment with an effective amount of a compound of Formula **I**. Also disclosed are compositions comprising a compound of Formula **I** and at least one additional active ingredient selected from the group consisting of an other herbicide and a herbicide safener.